HARVEY GENE HAWKINS, JR.

ASA

D6.1—1961

Manual on Uniform Traffic Control Devices for Streets and Highways

Prepared by the National Joint Committee on Uniform Traffic Control Devices:

American Association of State Highway Officials

Institute of Traffic Engineers

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American Municipal Association

U. S. DEPARTMENT OF COMMERCE
BUREAU OF PUBLIC ROADS
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APPROVED BY:

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Institute of Traffic Engineers
National Committee on Uniform Traffic Laws and Ordinances
National Association of County Officials
American Municipal Association

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INTRODUCTION

Traffic control devices are all signs, signals, markings, and devices placed on or adjacent to a street or highway by authority of a public body or official having jurisdiction to regulate, warn, or guide traffic.

Modern highways and vehicles operating thereon, together with changes in our way of life, have resulted in ever-increasing ranges of travel to the end that highway users have come to depend on traffic control devices for information, warning, and guidance. So great is this dependence that uniform, high-quality devices are necessary to productive use and public acceptance of any highway regardless of its excellence in width, alinement, and structural design.

The need for high uniform standards was recognized long ago. The American Association of State Highway Officials (AASHO) published a manual for rural highways in 1927 and the National Conference on Street and Highway Safety published a manual for urban streets in 1929. But the necessity for unification of the standards applicable to different road and street systems was obvious. To meet this need, a joint committee of the American Association of State Highway Officials and the National Conference on Street and Highway Safety developed and published in 1935 the original edition of this Manual on Uniform Traffic Control Devices. That committee, though changed from time to time in organization and personnel, has been in continuous existence and has been responsible for periodic revisions of the Manual, including this 1960 edition.

Membership on the National Joint Committee on Uniform Traffic Control Devices has changed considerably during the years. The Institute of Traffic Engineers joined the Committee in 1942 and the National Committee on Uniform Traffic Laws and Ordinances replaced the National Conference on Street and Highway Safety in 1948. In 1960 the Committee was reorganized to include members from the National Association of County Officials (NACO) and the American Municipal Association (AMA). Currently the latter two associations each appoint two chief administrative officers as representatives. The American Association of State Highway Officials appoints seven members, two of whom are chief administrative officers. The Institute of Traffic Engineers appoints seven members (usually city traffic engineers), and the National Committee on Uniform Traffic Laws and Ordinances appoints seven members. Members from the National Committee on Uniform Traffic Laws and Ordinances represent nonofficial associations and organizations. They also provide necessary liaison to insure agreement between the Uniform Vehicle Code, the Model Traffic Ordinance, and the Manual.

The six chief administrative officers appointed by the three associations of officials (AASHO, NACO and AMA) have major concern as to matters of policy in representing their respective associations. All modifications or new Manual materials must be approved by the five sponsoring organizations. Such approval constitutes both official and professional endorsement of use of the Manual in all States, counties, and cities.

Requirements of Traffic Control Devices

Any traffic control device should meet five elementary requirements:

1. It should be capable of fulfilling an important need.
2. It should command attention.
3. It should convey a clear, simple meaning.
4. It should command respect of road users.
5. It should be located to give adequate time for response.

In addition, devices which control or regulate traffic must be sanctioned by law.

Four basic considerations are employed to insure that these requirements are met. They are: design, placement, maintenance, and uniformity.

Design of the device must assure that such features as size, contrast, colors, shape, composition, and lighting or reflectorization where needed, are combined to draw attention to the device; that shape, size, colors, and simplicity of message combine to produce a clear meaning; that legibility and size combine with placement to permit adequate time for response; and that uniformity, reasonableness, size, and legibility combine to command respect.

Placement of the device must assure that it is within the cone of vision of the normal user so that it will command attention; that it is positioned with respect to the point, object, or situation to which it applies to aid in conveying the proper meaning; and that its location, combined with suitable legibility, is such that a driver traveling at normal speed has adequate time to make the proper response.

Maintenance of devices must be to high standards to assure that legibility is retained, that the device is visible, and that it is removed if no longer needed. Clean, legible, properly mounted devices in good working condition command respect. They have a businesslike appearance that implies that they are official and enforced—thus earning the respect of motorists. In addition to physical maintenance, functional maintenance is required to keep traffic control devices current. The fact that a device is in good physical condition should not be a basis for deferring needed replacement or change. A device must be functionally sound or it has outlived its usefulness. Furthermore, carelessly executed maintenance can destroy the value of a group of devices by throwing them out of balance. For example, replacement of a sign in a group or series by one that is disproportionately large may tend to depreciate others in the vicinity; maintenance must be functional as well as physical to guard against such occurrences.

Uniformity of traffic control devices simplifies the task of the road user because it aids in instant recognition and understanding. It aids police courts and road users by giving everyone the same interpretation. It aids public highway and traffic officials through economy in manufacture, installation, maintenance, and administration.

Simply stated, uniformity means treating similar situations in the same way. The use of uniform traffic control devices does not, in itself, constitute uniformity. In fact, using a standard device where it is not appropriate is as objectionable as using a nonstandard device.

Engineering Study Required

The decision to use a particular device at a particular location must be made on the basis of an engineering study at the location. Thus, while this Manual describes the application of the various devices, it is not intended as a substitute for engineering judgment. Nor is it intended to discourage the imaginative application of the standards and principles which the Manual prescribes. Both engineering judgment and imaginative application are essential to true uniformity.

Furthermore, the National Joint Committee on Uniform Traffic Control Devices has provided for limited and rigidly restricted recognition of proposals for experiment or research which it believes may hold promise for advances in this ever-developing field. The Joint Committee requests that it be informed of all new significant research and development which may affect future designs, standards, and uses. The Committee will periodically review the standards with the objective of revising those which can be improved. Such review and revision will be based largely on the finding of approved experimentation and research.

Legal Authority

In the case of regulatory devices, the meaning of each and the actions required of motorists and pedestrians should be specified by State statute, or by local ordinance or resolution. There is still wide variation in these laws throughout the country, however, and the same device does not everywhere and always mean the same thing to highway users. Obviously, uniformity of rules of the road is fundamental to true uniformity of traffic control devices.

Two publications by the National Committee on Uniform Traffic Laws and Ordinances are specifically designed to provide the content and language of legislation needed to give regulatory devices the same meaning in all jurisdictions. These are the Uniform Vehicle Code (chapter 11, Rules of the Road) for States, and the Model Traffic Ordinance for municipalities.[1] Both the Code and the Ordinance require the placing of signs or other traffic control devices to make some of their provisions effective, and both define the legal meaning of certain devices. The Code directs the State authorities to adopt a manual for a uniform system of traffic control devices, and the Ordinance requires devices under municipal jurisdiction to conform thereto. The adoption of this legislation is a logical first step toward uniformity.

Responsibility for Control Devices

The responsibility for selecting, installing, operating, and maintaining traffic control devices rests with a multitude of jurisdictions. In many States, State and local officials are required by statute to conform to this Manual, or to a State manual which must be in substantial conformance with this Manual. Federal legislation provides that any signs, signals, or markings installed on highways constructed with Federal-aid funds (since December 20, 1944) shall be subject to approval of the State highway department with the concurrence of the Secretary of Commerce, who is directed by the law to concur only in installations that promote safe, efficient highway use. Bureau of Public Roads regulations, in practical application of the law, call for conformity with standards adopted by the American Association of State Highway Officials, approved by the State highway department, and concurred in by the Federal Highway Administrator.

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[1] The *Uniform Vehicle Code* (1956), $1.00, and the *Model Traffic Ordinance* (1956), 50 cents, are published by and available from the National Committee on Uniform Traffic Laws and Ordinances, 702 Sheraton Bldg., 711—14th St., NW., Washington 5, D.C.

On all streets and highways the need is great for high, uniform standards of traffic control to protect the public investment in the Nation's roads and streets, and to foster safety, convenience, and economy of operation.

In many jurisdictions, particularly small counties and cities, the problem is not simple. Qualified engineers are needed to exercise the engineering judgment inherent in the selection of traffic control devices, just as they are needed to locate and design the roads and streets which the devices complement. Yet many small jurisdictions with responsibility for traffic control do not have qualified engineers on their staffs. Those jurisdictions should seek assistance on difficult problems from the State highway department, their county, a nearby large city, or a qualified traffic consultant.

Small cities and counties should find this Manual of great value in meeting their responsibilities for traffic control. The standards and principles enunciated here are just as applicable to their problems as they are to large metropolitan areas. These standards and principles can be of great value in finding solutions to traffic situations and weighing the merits of proposals advanced by various citizen groups.

Guiding Principles

This Manual sets forth the basic principles that govern the design and usage of traffic control devices. These principles appear throughout the text in discussions of the devices to which they apply, and it is important that they be given top consideration in the selection and application of each device.

The standards in this Manual apply to any and all streets and highways regardless of type or class or the governmental agency having jurisdiction. Where a device is intended for limited application only, or for a specific system, the text specifies the restrictions on its use.

Although this Manual, wherever practicable, includes detailed references to standards for the Interstate System of highways, the *Manual for Signing and Pavement Marking of the National System of Interstate and Defense Highways,* published by the American Association of State Highway Officials, should be consulted in the planning of any signing or marking projects on the Interstate System.

Definitions

Certain terms are defined as they appear initially in this Manual. In addition, such terms and all others for which definitions are needed are presented in appendix A. These terms are grouped alphabetically under each of five headings: General, Signs, Markings, Signals, and Islands.

1960 Revision

In addition to a great many minor changes that are intended to make the design and application of traffic control devices more adequate for modern highways, without wide departure from the basic standards of previous editions, this 1960 revision of the Manual now includes specific provisions for signing expressways, with references to standards for the Interstate System wherever applicable. It also includes, for the first time, an extensive special treatment of traffic control devices for highway construction and maintenance operations (part V) and a group of special signs for emergency civil defense applications (part VI). Standards for traffic signals (part III) have been modernized in keeping with technical advances in that field.

It is assumed that a reasonable time will be allowed for the gradual replacement of any existing installations that may be made obsolete by the new standards.

Part I

SIGNS

A—INTRODUCTION AND GENERAL SPECIFICATIONS

Section 1A–1 Function of Signs

The oldest device for controlling, safeguarding, or expediting traffic is the traffic sign. As in the case of any other type of traffic control device, signs should be used only where necessary and where justified by facts and field studies. Signs are not ordinarily needed to confirm well-known or universally recognized rules of the road, such as that requiring drivers to keep to the right, but they are essential where special regulations apply at specific places or at specific times only, or where hazards are not self-evident. They are also needed to give information as to highway routes, directions, destinations, and points of interest.

1A–2 Scope of Sign Standards

This Manual prescribes standards for the signing of all classes of public highways. To the extent that advanced design has reduced physical hazards and traffic frictions, the need for warning and regulatory signs on modern highways has been eased. On the other hand, the increased volume and speed of traffic on elaborate expressways has made the requirements of directional signing progressively more exacting. The standards in this Manual are designed for the great bulk of the street and highway mileage that constitutes the basic road system. At the same time, however, the special needs of expressways are recognized and, where appropriate, special expressway sign standards are prescribed.

For the purposes of this Manual, "expressways" include all types of high-speed highways, usually characterized by three distinctive features—divided roadways, controlled access, and grade separations at intersections. Where any of these features are lacking, expressway signs may not be fully applicable, and standard signs and signals as otherwise provided for should be used, with such enlargement or other modification as is required to adapt them to expressway conditions.

It must be emphasized that highway signs, and particularly expressway signs, are not just accessories, to be erected where they appear to be needed after a highway has been designed and built. On the contrary, there must be from the beginning a coordination of signing and geometric design. A dangerous alinement cannot be corrected by signs. An elaborately conceived interchange cannot serve its purpose unless motor-vehicle drivers can be given all necessary directional information by adequate signs, clearly comprehensible and effectively placed.

This Manual also includes two special parts dealing separately with construction and maintenance signing (part V), and with signing for civil defense (part VI). Signing for the protection of the public and the workmen at highway construction and maintenance sites is a specialized operation which, though it uses standard signs, calls for numerous special designs and applications. It is separately treated primarily in order that its specifications will be conveniently available to contractors and highway employees who are not concerned with other parts of this Manual.

Signs for civil defense (with the exception of the Evacuation Route Marker) are strictly for emergency use, and will be posted only in case of civil disaster. They are designed to fit the organized program for emergency traffic control with maximum economy in production, and they conform only to a minimum extent with conventional sign standards.

For the National System of Interstate and Defense Highways the American Association of State Highway Officials has established special standards, approved by the Bureau of Public Roads, consistent with the more generally applicable requirements set forth in this Manual but designed to provide maximum uniformity on a particular system of high-type expressways. The AASHO manual for the Interstate System should be consulted directly for any signing to be done on Interstate highways.[2]

1A–3 Legal Authority

Traffic signs shall be placed only by the authority of a public body or official having jurisdiction, for the purpose of regulating, warning, or guiding traffic. No traffic sign or its support shall bear any commercial advertising.

Any sign placed on the highway right-of-way without authority by a private organization or individual constitutes a public nuisance. All unofficial and nonessential signs should be removed, as they weaken the value of the necessary signs.

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[2] *Manual for Signing and Pavement Marking of the National System of Interstate and Defense Highways,* (1961). American Association of State Highway Officials, 917 National Press Building, Washington 4, D.C.

This, however, should not prohibit authorizing construction contractors and public utility companies, without obtaining specific permission in each case, to erect temporary construction and maintenance signs at work sites to protect the public, equipment, and workmen, provided that such signs conform to the standards of this Manual as to size, shape, and color.

A suitable model for the legal authority for the placing of signs is presented in the Uniform Vehicle Code (secs. 1–139, 11–201, 11–205, 15–104, 15–105, 15–106). Interference with official signs is prohibited in section 11–206 of the same Code.

The regulations set forth by signs should be intelligently enforced. Otherwise, no matter how effectively the signs are designed and placed, the results desired may not be obtained.

1A–4 Standardization of Application

Each standard sign shall be displayed only for the specific purpose prescribed for it in this Manual. Before any new highway or any detour or temporary route is opened to traffic all necessary signs shall be in place.

Signs required by road conditions or restrictions shall be removed immediately when those conditions cease to exist or the restrictions are withdrawn. Guide signs directing traffic to and on temporary routes or detours shall be removed when no longer applicable.

Important as is standardization with respect to design and placement, uniformity of application is at least equally important. Identical conditions should always be marked with the same type of sign, irrespective of where those particular conditions occur.

This Manual provides standards and criteria for the application and use of all types of signs. In any given situation, however, and particularly in circumstances not specifically covered by this Manual, the judgment and experience of the traffic engineer must be depended upon for the proper choice and application of the guiding standards here set forth.

It is recognized that urban conditions differ from rural in such respects as speeds, frequency of intersections, traffic congestion, numbers of pedestrians, parking, and competing lights and displays, and that in many instances signs must be differently applied and located. Where pertinent and practical, therefore, this Manual sets forth separate specifications for rural and urban conditions.

1A–5 Variable Signs

A type of sign that is of growing importance, particularly on high-speed expressways, is the variable sign that will at special times display emergency warnings, as of fog or icy surfaces ahead, or impose special regulations as to speed, turn prohibitions, or lane movement during peak-traffic periods. Such a sign may be changed manually on the spot, by remote control, or, for some purposes, by automatic controls that can "sense" the conditions that require special sign messages. It may have a single message that is made legible only when required, or several messages, of which one or more can be made legible at any time. There are various ways of accomplishing this, including patterns of incandescent lamps or of neon or fluorescent tubing that can be lighted when desired, translucent panels having the legend on the back side legible only when lighted from behind, or mechanical devices for masking parts of the sign or for the interchanging of panels.

Variable signs should conform to the design specifications generally applicable to standard signs. Because of their special features, however, it may not always be practicable to make them conform in all respects to the accepted standards of shape or (as in the case of fluorescent tubing) of color. They should meet the minimum standards for size and should be erected in accordance with the same requirements of height and clearances as other signs.

1A–6 Excessive Use of Signs

Care should be taken not to install too many signs, especially those of the regulatory and warning types which, if used to excess, tend to lose their effectiveness. A conservative use of regulatory and warning signs is recommended. On the other hand, a frequent display of route markers and directional signs to keep the driver informed of his location and his course will not lessen their value.

1A–7 Classification of Signs

Functionally signs are classified as follows:

Regulatory signs, giving the highway user notice of traffic laws or regulations that apply at a given place or on a given highway, disregard of which is punishable as an infraction, violation, or misdemeanor.

Warning signs, calling attention to conditions in or adjacent to a highway or street that are potentially hazardous to traffic operations.

Guide signs, showing route designations, destinations, directions, distances, points of interest, and other geographical or cultural information.

In addition to this functional classification it is sometimes desirable to classify according to special applications. Certain signs in all three of the above groups are distinguished in this Manual as expressway signs, and separate treatment is accorded to construction and maintenance signing (part V) and civil defense signs (part VI).

1A–8 Standardization of Signs

All signs hereafter installed on any highway shall conform to the standards set forth in this Manual. In situations where messages are required other than those herein provided for, the signs shall be of the same shape and color as standard signs of the same functional type.

The term "legend" as used in this Manual includes all word messages and symbol designs that are intended to convey specific meanings.

The basic requirements of a highway sign are that it be recognized as such, that it be legible for those who are to be informed by it, and that it be understood in time to permit a proper response. This means high visibility, lettering or symbols of adequate size, and a short legend for quick comprehension. Standardized colors and shapes should be used so that the several classes of traffic signs can be promptly recognized. The legend should be so limited as to be completely readable during the few seconds that a sign is visible to a driver approaching it at high speed. Simplicity and uniformity in design, position, and application are of the greatest importance.

As rapidly as is economically feasible, existing signs of nonstandard design or application should be replaced by new standard signs. Signs that are not dangerously inconsistent with current standards or not clearly inadequate may remain in use for a reasonable period of normal service life. Signs of substandard size or design, if otherwise suitable, should be relegated to minor roads or secondary streets.

1A–9 Design

Uniformity in design includes shape, color, dimensions, symbols, wording, lettering, and illumination or reflectorization. The Bureau of Public Roads, on request, will furnish to State and local highway and traffic authorities, sign manufacturers, and similarly interested agencies, detailed drawings of the standard signs illustrated in this Manual. These designs, both of symbols and of word messages, have been approved by the National Joint Committee on Uniform Traffic Control Devices after a thorough review of the varying designs used in many States, supplemented by test studies. Standardization of these designs does not preclude further improvement by minor changes in the proportion of symbols, stroke-width and height of letters, width of borders, or layout of word messages, but **all shapes and colors shall be as indicated, all symbols shall be unmistakably similar to those shown, and where a word message is applicable the wording shall be as herein provided.**

In the specifications here given for individual signs, the legend, color, and size are shown in the accompanying illustrations, and are not always detailed in the text.

1A–10 Shapes

The significance of sign shapes is standardized as follows:

The octagon shall be reserved exclusively for the Stop sign.

The equilateral triangle, with one point downward, shall be reserved exclusively for the Yield sign.

The round shape shall be used for the advance warning of a railroad crossing, and for the civil defense Evacuation Route Marker. It is also used for some State Route Markers.

The diamond shape shall be used only to warn of existing or possible hazards either in the roadway or adjacent thereto.

Regulatory signs, with the exception of Stop signs and Yield signs, shall be rectangular, ordinarily with the longer dimension vertical.

Guide signs, with the exception of certain route markers, shall be rectangular, ordinarily with the longer dimension horizontal.

Other shapes are reserved for special purposes; for example, the shield or other characteristic design for route markers on Interstate, U.S., and State highway routes, and the crossbuck for railroad crossings.

1A–11 Colors[3]

Warning signs, with the exception of the railroad crossbuck sign, shall have a background of "highway yellow" with black legend.

Regulatory signs, with the exception of the red Stop sign, the yellow Yield sign, and certain urban parking signs (sec. 1B–31), shall have a white background with black legend or, optionally for signs exceeding 30 inches by 36 inches in size, a black background with white legend.

> *Interstate.*—Standards for the Interstate System permit only a white background for all black and white regulatory signs.

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[3] Color cards showing the correct colors for highway signs may be obtained from the Bureau of Public Roads on request.

Guide signs, with the exception of certain route markers and Rest Area and Services signs, shall use only the colors white, black, and green. Destination, Distance, and Information signs, except Rest Area and Services signs for which special distinctive designs are permitted, shall have a black legend on a white background, white legend on a black background, or white legend on a green background. U.S. route markers, and auxiliary markers used in assemblies with them to show junctions, turns, directions, and alternates, shall have a black legend on a white background. Special exceptions for particular signs are noted in the specifications dealing with those signs.

> *Interstate.*—Interstate route markers and their auxiliaries are of special colors (sec. 1D–10). For other guide signs, standards for the Interstate System specify a green background with white legend or, for Rest Area and for Services signs, a blue background with white legend.

Tests have shown that white lettering on a dark background is slightly more legible than the reverse arrangement. On the other hand dark signs, unless they are of a substantial size, may not be as effective as white signs in attracting attention by daylight. Large guide signs of the expressway type should accordingly have a dark background, either green or black. For smaller Destination, Distance, and Information signs on expressways and elsewhere a white background is preferable, but a green or black background is a permissible alternative.

Wherever white is specified herein as a sign color, it is understood to include silver-colored reflecting coatings or elements that reflect white light.

1A–12 Dimensions

The sign dimensions prescribed in this Manual shall be standard for application on public highways. The size of a sign must depend primarily on the length of its message and the size and spacing of the letters that form the message, or on the size of any required symbol, when the complete legend is designed for adequate legibility. In this respect some flexibility is desirable to permit the use of a uniform sign plate for any particular series of signs.

The standard dimensions shown herein have been designed to provide clear legibility of the signs during the time and throughout the distance necessary for approaching traffic to read and comprehend their messages under "normal" highway conditions. Increases above these standard sizes are desirable where greater legibility or emphasis is needed, and for expressways special categories of large signs are prescribed. In determining whether the standard size is adequate, consideration should be given to such elements as prevailing speeds and volumes, the width of roadway or number of lanes, the degree of hazard (as appraised by a field survey of sight limitations, intersection complications, etc., or as revealed by accident records), and the competition offered by other signs, lighting, displays, or background. Any doubt should be resolved in favor of a larger sign.

In the enlarging of signs, standard shapes and colors shall be used, and standard proportions shall be retained insofar as practicable. Wherever practical the overall dimensions of the sign plates should be increased in 6-inch increments.

To permit the use of standard dies or templates, the lettering should be of a height measured in whole rather than fractional inches. Since, however, the approved lower-case letters specified for certain signs require initial capitals of a height 1⅓ times the "loop" height of the lower-case letters, fractional dimensions are standard for some of these initial capitals.

On minor roads and secondary streets signs of smaller than "standard" size may sometimes be justified. Such small signs should not be used except on roads or streets having not more than one lane of moving traffic in each direction and an 85-percentile speed of less than 30 miles per hour.

For expressways, on the other hand, the "standard" size is usually too small, and larger minimum sizes are generally provided for these high-type highways.

1A–13 Symbols

Symbol designs shall in all cases be essentially like those shown in this Manual.[4] A simple conventional symbol like the curve arrow, the directional arrow, or the intersection diagram is instantly recognized, and, wherever applicable, is to be preferred to a lettered message.

The Joint Committee believes that a wider adoption of symbols in preference to word messages, particularly on warning signs, is a desirable and important step toward the greater safety and facilitation of traffic. This view is strengthened by the general use of symbols in foreign countries, including Canada and the Latin American nations, and the increasing exchange of international travel between this and other countries. The Committee therefore proposes to adopt symbolization wherever practicable for new signs, taking due account of experience here and elsewhere, and recommends that a program of research be undertaken to determine the extent to which symbols may be superior to some of the word messages on signs in current use. During the introductory period for new symbols it may be desirable, for the education of the public, to supplement the symbols with word messages on the same signs or on supplementary plates.

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[4] Details of symbols are shown in the sign drawings available from the Bureau of Public Roads.

1A–14 Word Messages

Where applicable, standard wordings as shown in this Manual shall be used for sign legends. Most messages, particularly those of regulatory and informational signs, cannot adequately be conveyed by symbols. Word messages should be as brief as possible, and the lettering should be large enough to provide the necessary legibility distance.

Long words or messages, and long geographical names in particular, often present difficulties in the design of signs. Although it is specified that the sizes of sign plates should be determined by the necessary legend to be accommodated, there are sometimes practical limits to sign widths, as for an overhead sign that must extend over a single lane only, or a roadside sign adjacent to a steep cut bank, or an urban sign over a narrow sidewalk.

The narrower standard alphabets (sec. 1A–15) may be used where some condensation in word length is necessary. A further minor saving can be made by a small reduction in the spacing of the letters, but this impairs the legibility and is not recommended. In some instances abbreviations are expedient.

Abbreviations should be kept to a minimum, and should include only those that are commonly recognized and understood, such as Ave., Blvd., N. (for North), RR, or Jct. Two-word place names, where one part is a common geographical designation, like E. Lansing, Rockville Ctr., or Cleveland Hts., can often be acceptably abbreviated, but other abbreviations or contractions, like Gd. Rapids, S. Francisco, N. Brunswick, Newp't News, or Homest'd, are objectionable and should be avoided. Since long names can often be partially recognized by their length, it is sometimes permissible to put them in slightly smaller lettering than would otherwise be required.

1A–15 Lettering[5]

With the exception of destination names on guide signs, sign lettering shall be in clear, open capital letters of the type ap-

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[5] Detailed drawings of the standard capital and lower-case alphabets are supplied to highway departments and sign manufacturers by the Bureau of Public Roads.

proved by the National Joint Committee on Uniform Traffic Control Devices and its sponsoring agencies. Destination names may be in lower-case lettering, with initial capitals.

> *Interstate.*—On the Interstate System it is prescribed that destination names shall be in lower-case lettering, with initial capitals.

In no case should lettering be smaller than that indicated in the illustrations or text herein, and in the sign drawings available from the Bureau of Public Roads.

Use of the very narrow Series A alphabet is no longer acceptable in highway signs. In reflectorized signs other than street-name and parking signs the Series B alphabet should also be avoided because of its limited breadth and stroke width.

As a guide to choice of alphabets, tests have shown that, for any given legend, better legibility can be obtained by using a relatively wide spacing between letters than by using wider or taller letters with a cramped spacing.

1A–16 Illumination and Reflectorization

All signs that are to convey their messages during hours of darkness, other than urban parking signs, shall be reflectorized or illuminated. Much traffic moves after dark, and reflectorization or illumination may be necessary even on signs concerned primarily with daytime activities.

Street parking signs are ordinarily read at slow speeds, are relatively closely spaced, and often receive some illumination from street lighting, hence their reflectorization is optional.

Overhead signs, extending upward from a minimum of 15 feet above the roadway, may not receive enough illumination from motor vehicle headlamps for adequate brightness. **Overhead signs, accordingly, shall be illuminated where an engineering study shows that reflectorization will not give effective performance.**

1A–17 Means of Illumination

Illumination may be by means of:

1. A light behind the sign face, illuminating the main message or symbol, or the sign background, or both, through a translucent material; or

2. An attached or independently mounted light source designed to direct essentially uniform illumination over the entire face of the sign; or

3. Some other effective device, such as luminous tubing shaped to the lettering or symbol, patterns of incandescent light bulbs,

or luminescent panels that will make the sign clearly visible at night.

Ordinary street or highway lighting is not regarded as meeting the requirements for sign illumination.

All illumination shall be such as to show the same sign colors by night and by day. A flashing light incorporated in a sign installation shall be red when displayed with a Stop sign or yellow when displayed with a warning sign or other regulatory sign.

1A–18 Means of Reflectorization

In a reflectorized sign either the legend and border, or the background, or both, may be reflectorized, depending on the sign design and on local conditions. On any particular highway a consistent policy should be followed for signs of the same type, recognizing, however, differences in rural and urban requirements. As a general rule, both the legend and background of urban signs, if other than black, should be reflectorized.

Reflectorization may be by means of:

1. Reflector "buttons" or similar units set into the symbol or message; or
2. Reflecting coatings, either on the sign background or, where a white legend is used on a black or colored background, in the symbol or message and border.

Sign reflecting materials shall reflect white light, or if a reflecting coating is used as the background of a colored sign, the color of the background.

Reflecting material.—An effective reflecting material reflects a large proportion of an incident beam of light directly back toward its source, in a narrow cone having only enough "divergence" to reach the driver's eyes in his normal position above the headlamps. It is this "retrodirective" reflection that distinguishes reflector buttons and reflecting coatings from any sort of specular or diffuse reflectors and gives them their great brilliance.

Reflector buttons.—Reflector buttons in a highway sign are individual reflecting units arranged in rows or patterns to form letters, symbols, or borders. In suitable sizes and spacings they give the visual effect of continuous lines or areas or light. They are made of glass or transparent plastic with lenses or prisms designed for retrodirective reflection.

Reflecting coating.—A reflecting coating is a coating or sheeting applied either to the background or to the legend of a sign, or to both, to give a bright reflection over the entire area so covered. The coating or sheeting is of a retrodirective reflecting character, usually having minute glass spheres ("beads") closely distributed and embedded in a painted surface or in a flexible plastic sheeting, or minute lenses molded in the surface of a plastic sheeting. Each bead or lens acts as an individual reflecting unit, but the effect is that of a uniformly brilliant area when viewed in the headlamp beam. A suitable incorporation of pigment in a reflecting coating causes it to reflect colored light.

1A–19 Sign Borders

With few exceptions all signs illustrated herein have a narrow border, invariably of the same color as the legend, at or just inside the edge. This improves the appearance of the signs and makes them more conspicuous. A dark border should be set in from the edge, while a white border should extend to the edge of the plate. A suitable border for 30-inch signs having a light background is from one-half to three-quarters of an inch in width, one-half inch from the edge. For similar signs with a white border a width of an inch is appropriate. For other sizes the border widths should be of similar proportions, but not ordinarily to exceed the stroke-width of the major lettering of the sign. On expressway signs exceeding 6 feet by 10 feet in size the border should be approximately 2 inches wide, or, on unusually large signs, 3 inches.

In all sign specifications herein it is understood that where the illustration or text calls for a border, the border is of the same color as the legend, without any repeated statement to that effect.

The corners of the sign border shall be rounded. Where practicable, the corners of the sign panels should also be rounded to fit the border. Rounding the corners improves the appearance of the signs, and for signs mounted at a height of less than 7 feet is an important safety measure.

A suitable corner radius for sign plates up to 30 inches in their greater dimension is 1½ to 2 inches, with similar proportions for larger sizes. On large expressway guide signs the corners should be rounded on a radius of approximately ⅛ of the lesser side dimension, but not to exceed 12 inches. On such large signs the corner areas outside the rounded border need not be trimmed.

1A–20 Standardization of Position

Standardization of position cannot always be attained in practice, because signs must in all cases be placed in the most advantageous positions and must be accommodated to highway design and alinement. The general rule is to locate signs on the right-hand side of the roadway, where the driver is in the habit of looking for them. On wide expressways, or where some degree of lane-use control is desirable, or where space is not available at the roadside, overhead signs are often necessary. Signs in any other locations should ordinarily be considered only as supplementary to signs in the normal locations. Under some circumstances signs may advantageously be placed on channelizing islands or (as on sharp curves to the right) on the left-hand shoulder of the road, directly in front of approaching vehicles. A supplementary sign located on the left of the roadway is often helpful on a three- or four-lane road, or on a one-way roadway, where traffic in the right-hand lane interferes with the driver's view to the right.

Normally signs should be individually erected on separate posts or mountings, except where one sign supplements another, or where route or directional signs must be grouped. In rural areas two signs for different purposes should not be located closer together than 200 feet along the highway, though exceptions to this rule are sometimes necessary at intersections. Signs near together are difficult to read, especially at high speed.

Standard positions for a number of typical signs are illustrated in figures 1–1 to 1–3.

1A–21 Warrants for Overhead Signs

Overhead signs are generally justified only (1) where the message is applicable to a particular lane, or to particular lanes, over which the sign is placed, or (2) where traffic or roadway conditions are such that an overhead mounting is necessary for adequate visibility. Their principal applications, therefore, are on wide and heavily traveled highways, and particularly expressways.

Overhead signs are warranted:

1. Where control of traffic with reference to lane use can be made significantly more effective.
2. At or just in advance of a divergence from a heavily traveled roadway.
3. Where, as on a depressed or elevated urban expressway, there is no space for signs at the side of the roadway.
4. On roadways of more than two lanes in one direction, where heavy traffic will interfere with the visibility of roadside signs.
5. Where there is a relatively large volume of nonlocal traffic unfamiliar with the highway and needing particularly effective guidance.
6. Where interchanges on an expressway are spaced at less than 1 mile.

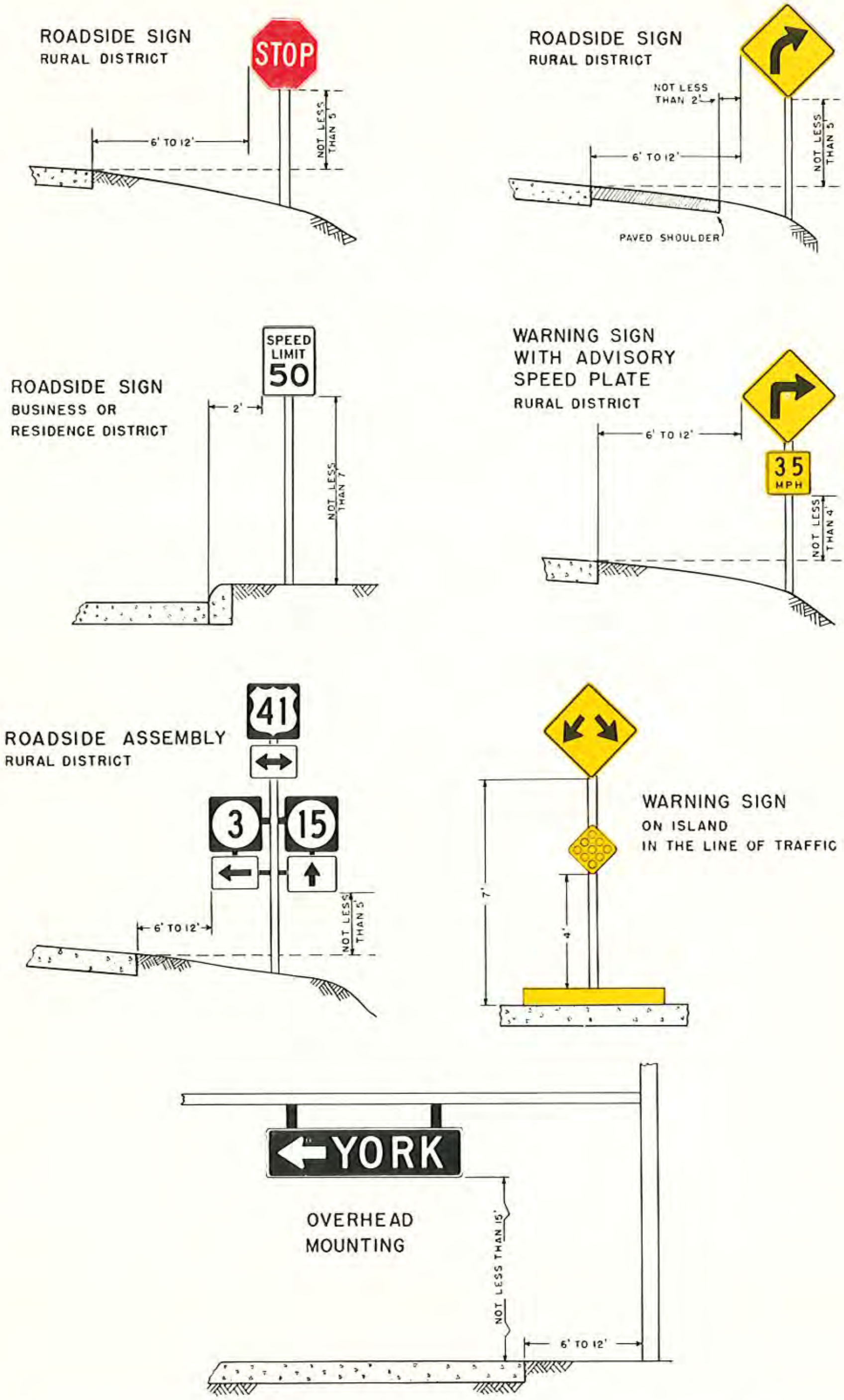
ROADSIDE SIGN
RURAL DISTRICT
STOP
6' TO 12'
NOT LESS THAN 5'
ROADSIDE SIGN
RURAL DISTRICT
NOT LESS THAN 2'
6' TO 12'
NOT LESS THAN 5'
PAVED SHOULDER
ROADSIDE SIGN
BUSINESS OR
RESIDENCE DISTRICT
SPEED LIMIT 50
2'
NOT LESS THAN 7'
WARNING SIGN
WITH ADVISORY
SPEED PLATE
RURAL DISTRICT
6' TO 12'
35 MPH
NOT LESS THAN 4'
ROADSIDE ASSEMBLY
RURAL DISTRICT
41
3
15
6' TO 12'
NOT LESS THAN 5'
WARNING SIGN
ON ISLAND
IN THE LINE OF TRAFFIC
7'
4'
YORK
OVERHEAD
MOUNTING
NOT LESS THAN 15'
6' TO 12'

Figure 1–1. Height and lateral location of signs—typical installations.

7. Where roadside development, as, for example, a brightly lighted area, seriously detracts from the effectiveness of roadside signs.

8. Where vertical or horizontal curvature of the roadway is such as to limit the long-range visibility of a roadside sign. In this situation consideration should first be given to relocating the roadside sign for better visibility.

9. Where on an expressway there is a nonsignalized pedestrian crosswalk.

10. For consistency, where other signs on a given stretch of highway are overhead.

> *Interstate.*—On the Interstate System it is prescribed that certain interchange Guide signs shall be placed overhead (sec. 1D–36).

1A–22 Height

Signs erected at the side of the road in rural districts shall be mounted at a height of at least 5 feet above the level of the roadway edge, measured to the bottom of the sign. On expressways this height shall be at least 6 feet. In business and residence districts, and in any case where parking is likely to occur or where there are other obstructions to view, the height shall be at least 7 feet. The height to the bottom of a secondary sign mounted below another sign may be 1 foot less than the appropriate height specified above, and for a secondary sign below a large expressway directional sign the height may be as low as 4 feet to avoid excessive height for the top of the major sign. A high clearance above the ground is often advantageous, but may reduce the effectiveness of reflectorization.

A route marking assembly consisting of a Route Marker with an auxiliary plate (sec. 1D–9) is treated as a single sign for the purposes of this section.

> *Interstate.*—Standards for the Interstate System prescribe a minimum height of 7 feet for roadside directional signs, or, if a secondary sign is mounted below another sign, 8 feet for the major sign and 4 feet for the secondary sign. Route markers and warning and regulatory signs shall be at a minimum height of 6 feet.

The clear height of overhead signs and sign structures shall be not less than 15 feet over the entire roadway width, including the usable width of shoulders.

> *Interstate.*—On the Interstate System it is prescribed that overhead signs shall have a vertical clearance of at least 17 feet over the roadway.

1A–23 Lateral Clearance

Roadside signs shall be placed at the edge of the road shoulder with the nearest edge of the sign not less than 6 feet nor more than 12 feet from the edge of the pavement or traveled way, except where conditions do not permit or where other requirements are specified elsewhere in this Manual with respect to particular signs. Where a raised curb, guardrail, or paved shoulder is present a sign should ordinarily be placed with its nearest edge at least 2 feet outside such curb line, guardrail, or paved shoulder.

In urban areas a clearance of 1 foot from the curb line is permissible where sidewalk width is limited or existing poles are close to the curb.

Expressway signs, other than overhead signs, shall be erected at a minimum distance of 2 feet outside the usable roadway shoulder, to the right or left side of the roadway, or a minimum of 2 feet outside any unmountable curbing present. Where practicable, a sign should be not less than 10 feet from the edge of the nearest traffic lane. Lesser clearances, but not generally less than 6 feet, may be used on connecting roadways or ramps at interchanges.

> *Interstate.*—Standards for the Interstate System require that clearances shall be 2 feet beyond the edge of the roadway shoulder or beyond the face of an unmountable curb.

The above standards for minimum lateral clearance shall apply also to structures for the support of overhead signs. Where an expressway median is 12 feet or less in width, consideration should be given to spanning both roadways without a center support. If an overhead sign support is to be placed in a curbed island or gore, a clearance of at least 2 feet from the curb face should be provided.

For overhead sign supports, guardrails suitable for the protection of motorists should be installed approximately at the outer edge of the shoulder. Similar protection may be necessary at some installations of roadside signs.

> *Interstate.*—Standards for the Interstate System make guardrail protection for overhead sign structures mandatory.

1A–24 Location of Signs

A warning sign is generally placed in advance of the condition to which it calls attention (figs. 1–4, 5). A regulatory sign, as a rule, is placed where its mandate or prohibition applies. A Stop sign, for example, is erected as near as practicable to the point where the stop is to be made. Parking signs mark the limits of the restricted zones. Some regulatory signs are repeated at intervals along a continuous stretch of highway to which a restriction applies. Guide signs are placed at and in advance of intersections and interchanges, and between such points of decision, in such a manner as to keep the driver well informed as to the route to his destination. Figures 1–6 to 1–8 show the placement of intersection guide signs on other than expressways. Detailed specifications for sign locations are given in the sections of this Manual dealing with individual signs or classes of signs.

1A–25 Erection

All signs shall be mounted approximately at right angles to the direction of, and facing, the traffic that they are intended to serve.

Where mirror reflection from the sign face is encountered in such degree as to reduce legibility, the sign should be turned slightly away from the road. At curved alinements the angle of placement should be determined by the course of approaching traffic rather than by the roadway edge at the point where the sign is located. Sign faces are normally vertical, but on grades it may be desirable to tilt a sign forward or back from the vertical to improve the viewing angle.

1A–26 Posts and Mountings

Sign posts and their foundations shall be so constructed as to hold signs rigidly in a proper and permanent position, to resist swaying in the wind or displacement by children or vandals. Signs wider than 48 inches or larger than 10 square feet in area may advantageously be mounted on two posts. Large expressway guide signs and overhead signs require substantial structures, designed to withstand the heavy stresses of wind and load.

Each State and local highway authority should adopt for sign posts the material and design dictated by local resources and past experience as the most satisfactory and economical. Most of the standard sign plates have a bolt-hole spacing that will permit their mounting on posts having holes spaced on 3–inch centers. Commercially available metal posts are commonly punched with holes on 1-inch centers, to fit any plate. Wooden posts can be drilled in the field as required.

In some cases, especially in urban districts, signs can be correctly placed on existing supports used for other purposes, such as traffic signal standards, street lamps, or public utility poles, thereby saving expense and minimizing sidewalk obstruction.

Correct location of the sign should not thus be sacrificed, however. Utility poles should be used only with the permission of the controlling company.

A portable or removable type of mounting is desirable for signs used temporarily or intermittently. Such a mounting should have sufficient stability to resist overturn in strong winds.

1A–27 Sign Materials

A variety of materials can be used effectively for permanent signs, and the choice among them will depend largely on local experience and the local availability of satisfactory materials. Most of the highway departments of the States and larger cities have suitable specifications that can be obtained by smaller communities having limited facilities for the designing of signs.

It is recognized that technological progress may develop new and satisfactory or superior materials for highway signs, particularly in the fields of illumination and reflectorization. Nothing in this Manual should be interpreted to exclude any new material that meets the standard requirements for color and visibility.

1A–28 Maintenance

All traffic signs shall be kept in proper position, clean, and legible at all times. Damaged signs shall be replaced immediately.

Signs poorly maintained lose their authority as traffic control devices. Damaged, defaced, or dirty signs are ineffective and discredit the agency responsible for them.

To insure adequate maintenance a suitable schedule for inspection, cleaning, and replacement of signs should be established. All signs should be inspected at least twice a year and any that are defective should be cleaned, touched up, or replaced and taken in for repair and refinishing or scrapping. Employees of the highway department, traffic police, and other governmental employees whose duties require that they travel on the highways should be instructed to report any damaged or obscured sign at once.

Special care should be taken to see that weeds, shrubbery, construction materials, and snow are not allowed to obscure the face of any sign.

In the case of illuminated signs a regular schedule for replacement of lighting elements should be maintained, so that such elements will be renewed before they would normally be expected to burn out.

As a useful guide to sign maintenance the American Association of State Highway Officials' *Policy on Maintenance of Safety and Traffic Control Devices* is recommended.[6]

1A–29 Reflector Markers

Small reflecting units at the roadside are widely used to mark culverts and other hazards, or, in series, to indicate the alinement of the road. In the latter application they are known as delineators. Although like signs they are usually mounted on posts and convey a warning to the driver, they are more closely related to obstruction markings or to guide lines. They are accordingly treated in this Manual as markings (secs. 2D–1 to 2D–5).

B—REGULATORY SIGNS

Section 1B–1 Application of Regulatory Signs

Regulatory signs shall be used to inform highway users of traffic laws or regulations that apply at given places or on given highways, disregard of which is punishable as an infraction, violation, or misdemeanor. They are essential to indicate the applicability of legal requirements that would not otherwise be apparent. Great care must be exercised to see that they are erected wherever needed to fulfill this purpose, but unnecessary mandates should be avoided.

Included among regulatory signs are some, like those marking the end of a restricted zone, that are related to operational controls, though not in themselves imposing any obligations or prohibitions.

Regulatory signs shall normally be erected at those locations where the regulations apply, and shall be mounted so as to be easily visible and legible to the motorist whose actions they are to govern. The message on the sign shall clearly indicate the requirements imposed by the regulation. Signs that have been erected but are no longer applicable shall be removed. Regulatory signs cannot be expected to command respect and obedience unless the regulations therein set forth are adequately enforced.

Although regulations may differ widely from one location to another, depending on traffic requirements, highway conditions, and local legislation, it is possible to establish uniform standards of application, location, size, shape, colors, and dimensions for different types of regulatory signs, so that the motorist can always recognize them quickly.

Regulatory signs on expressways must ordinarily be larger than on other highways, for quicker recognition. Otherwise standard shapes, colors, and legends are used, where applicable. A few special messages are required to deal with particular features of expressway design. Such regulations as are necessarily imposed must be clearly posted to prevent improper or unexpected behavior in fast or high-volume traffic. With an increasing mileage of expressways in use, drivers can be expected to become familiar with expressway traffic controls, and regulatory signs should be used only where there is an apparent need for them.

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[6] *Policy on Maintenance of Safety and Traffic Control Devices and Related Traffic Services*, $1.50, available from the American Association of State Highway Officials, 917 National Press Bldg., Washington 4, D.C.

1B–2 Classification of Regulatory Signs

Regulatory signs are classified in the following groups:

1. Right-of-way series:
   - (a) Stop sign (secs. 1B–4 to 6, 9).
   - (b) Yield sign (secs. 1B–7 to 9).
2. Speed series (secs. 1B–10 to 15).
3. Movement series:
   - (a) Turning (secs. 1B–16 to 20).
   - (b) Alinement (secs. 1B–21 to 25).
   - (c) Exclusion (secs. 1B–26, 27).
   - (d) One way (secs. 1B–28 to 30).
4. Parking series (secs. 1B–31 to 33).
5. Pedestrian series (secs. 1B–34 to 36).
6. Miscellaneous series (secs. 1B–37 to 41).

1B–3 Design of Regulatory Signs

With few exceptions, hereinafter detailed in the specifications for individual signs, regulatory signs are rectangular in shape, with the larger dimension vertical, and have black legend on a white background. For signs 30 inches by 36 inches in size, or larger, white legend on a black background is a permissible alternate. The principal exceptions referred to are the Stop sign, the Yield sign, the horizontal One Way sign, and street parking signs.

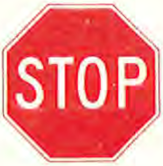
> *Interstate.*—On the Interstate System, the black background for regulatory signs is not permitted, regardless of size.

Standard dimensions are given for each regulatory sign specified herein. On minor roads and secondary streets (having not more than one moving lane of traffic in each direction and an 85-percentile speed of less than 30 miles per hour) a smaller design is warranted for some of the signs, as indicated in the individual specifications. On the other hand, where conditions require greater visibility and legibility than can be provided by the standard sign, larger signs should be used. On expressways a special class of large signs is called for.

All regulatory signs, unless definitely excepted in the specifications herein covering a particular sign or group of signs, shall be reflectorized or illuminated (secs. 1A–17, 18).

1B–4 Stop Sign (R1–1)

It is commonly provided by law that State and local authorities, with reference to highways under their respective jurisdictions, may designate through highways and erect Stop signs at specified entrances thereto, or may designate any intersection as a stop intersection and erect like signs at one or more entrances to such intersection, or at any location necessary to control traffic within an intersection. A suitable model for Stop sign legislation is to be found in the Uniform Vehicle Code (secs. 11–403, 11–705, and 15–108).



R1–1
30″ x 30″

The Stop sign shall be octagonal in shape, shall have a red background, and shall carry the word STOP in white letters at least one-third the height of the sign. It shall have a standard size of 30 inches by 30 inches. On minor roads and secondary streets (sec. 1B–3) a sign 24 inches by 24 inches in size may be used.

A flashing red beacon, in operation both by day and by night, may be used in conjunction with a Stop sign. It should generally be mounted just above the sign.

Secondary messages shall not be used on Stop signs.

1B–5 Warrants for Stop Sign

Only general policy statements can be proposed for Stop sign warrants at this time. Conditions warranting Stop signs are:

1. Intersection of a less important road with a main road where application of the normal right-of-way rule is unduly hazardous.
2. Intersection of a county road, city street, or township road with a State road.
3. Intersection of two main highways where no traffic signal is present.

4. Street entering a through highway or street.

5. Unsignalized intersection in a signalized area.

6. Railroad crossing where a stop is required by law or by order of the appropriate public authority.

7. Other intersection where a combination of high speed, restricted view, and serious accident record indicates a need for control by the Stop sign.

Stop signs will never be used on the through roadways of expressways. Expressway interchanges, moreover, should be designed for continuously flowing traffic, making Stop signs generally unnecessary and unwarranted even on the entering roadways. Where for strictly local traffic in sparsely populated areas grade intersections may temporarily be justified, Stop signs must be used on the entering roadways to protect the through traffic. Stop signs may also be required at the far end of diverging roadways where they intersect other highways not designed as expressways. In most such cases the speeds will not be such as to require any great increase in sign sizes.

Stop signs should not be erected at intersections where traffic control signals are present. The conflicting commands of two types of control devices are confusing. If traffic is required to stop when the operation of stop-and-go signals is not warranted, the signals should be put on flashing operation with the red flashing light facing the traffic that must stop.

Where two main highways intersect, the Stop sign or signs should normally be posted on the lesser street to stop the lesser flow of traffic. Authoritative traffic engineering studies, however, may justify a decision to install a Stop sign or signs on the major street, as at a three-way intersection where safety considerations may justify stopping the greater flow of traffic to permit a left-turning movement.

Many of the conditions covered by the Stop sign warrants above can be dealt with by Yield signs with less inconvenience to the public. Use of the Yield sign should be considered where sight distances are adequate and where a full stop at all times is not necessary for safety.

1B–6 Four-Way Stop Signs

The "Four-Way Stop" installation, where legal, has been found useful as a safety measure at some locations. It should not ordinarily be used where the volume of traffic on the intersecting roads is very unequal. Where there is a heavy volume of traffic a traffic control signal installation is more satisfactory.

Any of the following conditions may warrant a four-way Stop sign installation:

1. Where traffic signals are warranted and urgently needed, the four-way stop is an interim measure that can be installed quickly to control traffic while arrangements are being made for the signal installation.

2. An accident problem, as indicated by five or more reported accidents of a type susceptible of correction by a four-way stop installation in a 12-month period. Such accidents include right- and left-turn collisions as well as right-angle collisions.

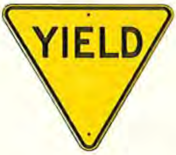
3. Minimum traffic volumes:

(a) The total vehicular volume entering the intersection from all approaches must average at least 500 vehicles per hour for any 8 hours of an average day, and

(b) The combined vehicular and pedestrian volume from the minor street or highway must average at least 200 units per hour for the same 8 hours, with an average delay to minor street vehicular traffic of at least 30 seconds per vehicle during the maximum hour, but

(c) When the 85-percentile approach speed of the major street traffic exceeds 40 miles per hour, the minimum vehicular volume warrant is 70 percent of the above requirements.

At a four-way stop intersection each Stop sign may be supplemented by a separate plate mounted just below it, reading 4-WAY, in black letters on a white background. The standard size for such plate should be 12 inches by 6 inches.



R1–2
36″ x 36″ x 36″

1B–7 Yield Sign (R1–2)

The YIELD sign shall be an equilateral triangle with one point downward, having a black legend on a yellow background. The sides of the triangle shall have a standard, and minimum, length of 36 inches, giving the sign a nominal height of approximately 30 inches after rounding of the corners. On an expressway the sides shall be at least 48 inches. The Yield sign shall be located and erected in the same manner as the Stop sign.

The Yield sign requires a stop only when necessary to yield right-of-way to crossing traffic. Suitable legislation should be adopted to define its meaning and to authorize its use. It should not be regarded as a substitute for the Stop sign where a Stop sign is warranted. A suitable model for Yield sign legislation is to be found in the Uniform Vehicle Code (secs. 11–403, 11–705, and 15–108).

1B–8 Warrants for Yield Sign

Generally the Yield sign serves a purpose similar to that of the Stop sign, in that it assigns right-of-way to traffic on certain approaches to an intersection. Since it does not require all vehicles to stop, it should not be used where visibility limitations or prevailing high speeds or volumes of traffic make a full stop necessary for safety.

The Yield sign is warranted:

1. On a minor road at the entrance to an intersection where it is necessary to assign right-of-way to the major road, but where a stop is not necessary at all times, and where the safe approach speed on the minor road exceeds 10 miles per hour.
2. On the entrance ramp to an expressway where an acceleration lane is not provided.
3. Within an intersection with a divided highway, where a Stop sign is present at the entrance to the first roadway and further control is necessary at the entrance to the second roadway, and where the median width between the two roadways exceeds 30 feet.
4. Where there is a separate or channelized right-turn lane, without an adequate acceleration lane.
5. At any intersection where a special problem exists and where an engineering study indicates the problem to be susceptible to correction by use of the Yield sign.

Yield signs should not ordinarily be placed against the major flow of traffic at an intersection. They should never be erected on the approaches of more than one of the intersecting streets or highways. Nor should they be used at any intersection where there are Stop signs on one or more approaches, except, under special circumstances, to provide minor movement control within complex intersections.

Yield signs will never be used on the through roadways of expressways. On an entering roadway without an adequate acceleration lane a Yield sign may properly be used, but in a well designed interchange the sign will interfere with the free merging movement, and its use under such circumstances is not approved.

Interstate.—On the Interstate System the Yield sign may be used on entrance roadways where conducive to safe and orderly merging movement, but not ordinarily where full-length acceleration lanes exist.

1B–9 Location of Stop Sign and Yield Sign

A Stop sign shall always be erected at the point where the vehicle is to stop or as near thereto as possible, and may be supplemented with a Stop line and with the word STOP on the pavement, as shown in figure 1–2. **A Yield sign shall be erected in the same manner, at the point where the vehicle is to stop if necessary to yield the right-of-way. In no case shall either sign be placed farther than 50 feet from the intersected roadway. Where there is a marked crosswalk on the pavement the sign shall be erected 4 feet in advance of the crosswalk line nearest to approaching traffic.**

Height and lateral placement of the sign shall be in accord with the general standards set forth in secs. 1A–22, 23.

Where only one sign is used it shall be on the right-hand side of the roadway. At an intersection where a wide throat exists on the signed approach, observance of the sign may be improved by the erection of an additional sign on the left side of the approach road, and by the use of a Stop line. At certain channelized intersections the sign may be effectively placed on a channelizing island.

In the event the visibility of a Stop sign or a Yield sign at any location is restricted, the sign shall be located as specified, and a Stop Ahead sign (sec. 1C–14) or a Yield Ahead sign (sec. 1C–15) shall be erected in advance of the Stop or Yield sign.

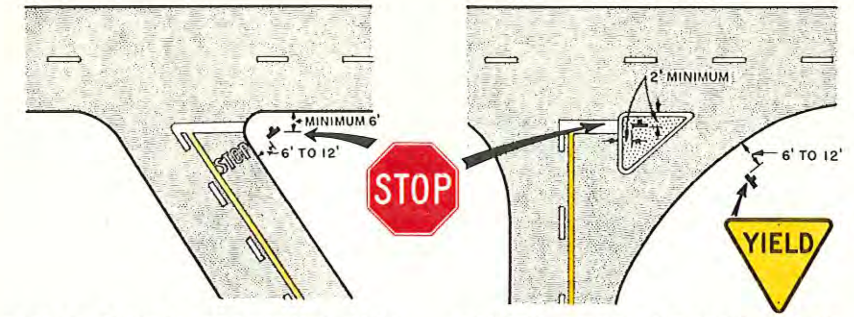
Figures 1–2, 1–6, 1–7, and 1–8 show typical Stop and Yield sign installations.

1B–10 Speed Limit Sign (R2–1)

The standard Speed Limit sign shall be 24 inches by 30 inches in size, with a minimum size for minor roadways (sec. 1B–3) of 18 inches by 24 inches. On expressways the sign should be at least 36 inches by 48 inches.

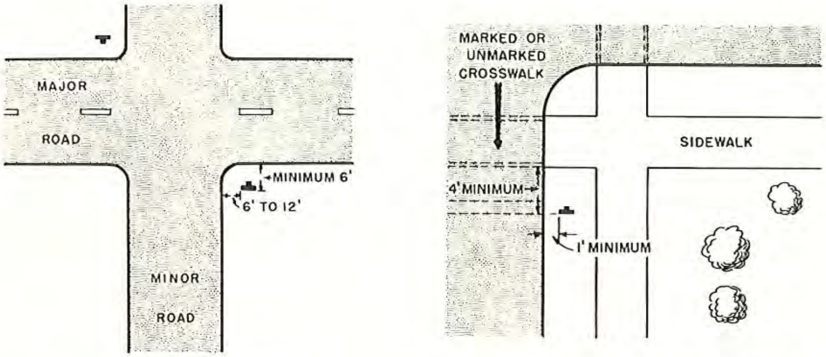
Interstate.—For the Interstate System a size of 48 inches by 60 inches is prescribed for this sign.

The numerical speed limit displayed on this sign shall be the limit established by law, or by regulation after an appropriate engineering and traffic investigation according to law. The speed limits shown should be in multiples of 5 miles. A suitable model for speed-limit legislation is to be found in the Uniform Vehicle Code (secs. 11–801 to 806).


MINIMUM 6'
6' TO 12'
STOP
STOP
2' MINIMUM
6' TO 12'
YIELD

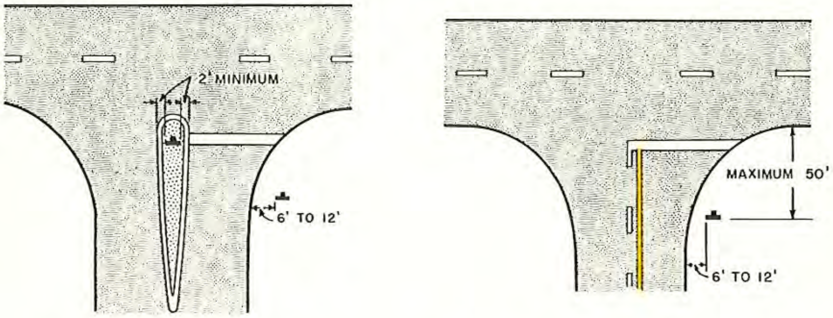
ACUTE ANGLE INTERSECTION

CHANNELIZED INTERSECTION


MAJOR
ROAD
MINIMUM 6'
6' TO 12'
MINOR
ROAD
MARKED OR
UNMARKED
CROSSWALK
SIDEWALK
4' MINIMUM
1' MINIMUM

MINOR CROSSROAD

URBAN INTERSECTION


2' MINIMUM
6' TO 12'
MAXIMUM 50'
6' TO 12'

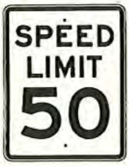
DIVISIONAL ISLAND

WIDE THROAT INTERSECTION

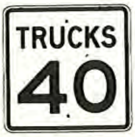
Figure 1–2. Typical locations for Stop signs and Yield signs. In the lower diagrams either sign may be appropriate.

Where a special speed limit applies to trucks or other vehicles the legend TRUCKS 40, or such similar message as is appropriate, should be shown below the standard message, on a separate plate (R2–2) or on an elongation of the standard plate.

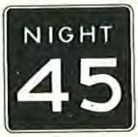
Interstate.—Standards for the Interstate System prescribe an advisory exit speed sign with the legend EXIT 30 M.P.H. (or other appropriate limit), 48 inches by 60 inches in size, to be erected where necessary on the right-hand side of the exit ramp, just beyond the gore. This sign, having black legend on a yellow background, is to be regarded as advisory only, though, for convenience, it is here cited in connection with official regulatory speed signs.



R2–1
24″ x 30″



R2–2
24″ x 24″



R2–3
24″ x 24″

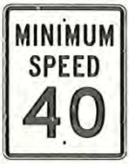
1B–11 Night Speed Sign (R2–3)

A special problem in speed signing is encountered in States where different day and night speed limits are prescribed. Although posting both speeds destroys the effective simplicity of the standard speed sign, it is necessary that the night limit be shown as well as the day limit. This can be done in either of two ways:

1. By erecting immediately below the standard Speed Limit sign (R2–1), or combining with it, a Night Speed sign (R2–3) carrying the legend NIGHT 45 (or other suitable numerical limit). In this case the numerals in the Night Speed sign and only the words SPEED LIMIT in the standard sign, should be reflectorized. As a special but logical exception to the general color scheme, the Night Speed sign should have its legend in white upon a black background.
2. By superimposing the night speed, in reflectorized numerals, over the daytime speed, in unreflectorized numerals, so that it becomes legible only in the beam of motor-vehicle headlamps at night.

1B–12 Minimum Speed Sign (R2–4)

Where an engineering and traffic investigation shows that slow speeds on a highway consistently impede the normal and reasonable movement of traffic, it is sometimes desirable to impose a minimum speed limit, below which it is illegal to drive except when necessary for safe operation or in compliance with law. In such case the Minimum Speed sign may be used. **It shall be of the same standard size and shall be posted in the same manner as standard Speed Limit signs.** A suitable model for minimum speed legislation is to be found in the Uniform Vehicle Code (sec. 11–804).



R2–4
24" x 30"

1B–13 Location of Speed Limit Sign

Speed Limit signs indicating legal speed limits shall, when used, be located at the points of change from one speed limit to another and at additional locations, as just beyond major intersections, where it is necessary to remind motorists of the limit that is applicable.

In rural districts on Interstate, U.S., and other State numbered routes, Speed Limit signs indicating the statutory speed limits shall be erected at the entrance to the State and at boundaries of metropolitan areas. A special oversize sign is often desirable at State boundaries.

Signs indicating altered or "zone" speed limits shall not be erected until the altered speed limits are approved and officially authorized. In such cases a Speed Limit sign shall be located at the beginning of each section where the speed is altered, and at appropriate intermediate locations. At the end of such a section there shall be erected a Speed Limit sign showing the next speed limit, or, in case there is no specified speed limit in the area about to be entered, an End (35) Mile Speed sign or an End Speed Zone sign (sec. 1B–15).

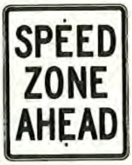
Speed Limit signs shall be erected in accordance with the general requirements for sign placement (secs. 1A–22, 23).

1B–14 Speed Zone Ahead Sign (R2–5)

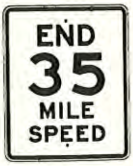
The SPEED ZONE AHEAD sign in rural areas, if used, shall be placed not less than 300 nor more than 1,000 feet in advance of the speed zone to which it applies. The sign will not ordinarily be needed in urban areas where speeds are relatively low.

This sign shall always be followed by the regular Speed Limit sign erected at the beginning of the zone where the altered speed limit applies.

The Speed Zone Ahead sign shall be of the same size as the Speed Limit sign at the beginning of the speed zone, and shall be erected in the same manner.



R2–5
24" x 30"



R2–6
24" x 30"

1B–15 End (35) Mile Speed Sign (R2–6)

The END (35) MILE SPEED sign may be displayed at the end of an authorized speed zone to inform motorists that they are leaving a section where the statutory speed limits have been altered. **If used it shall be of the same size as the Speed Limit sign (sec. 1B–10) at the beginning of the zone, and shall be erected in the same manner (sec. 1B–13).** As an alternate, the legend END SPEED ZONE (R2–7) may be used.

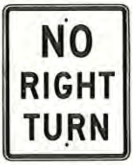
Posting the speed limit for the following section of highway with a regular Speed Limit sign (sec. 1B–10) eliminates the need for either of the end-of-zone signs. At least one of these three signs should be used, however.

1B–16 Turn Prohibition Signs (R3–1 to 4, inclusive)

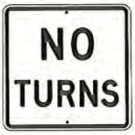
The standard, and minimum, size of the NO RIGHT TURN sign (R3–1) and the NO LEFT TURN sign (R3–2) shall be 24 inches by 30 inches; that of the NO TURNS sign (R3–3) shall be 24 inches by 24 inches. The standard size of the NO U TURN sign (R3–4) is 24 inches by 30 inches; however, a smaller size is permitted (sec. 1B–17).

Turn Prohibition signs should be placed where they will be most easily seen by drivers intending to turn. **The No Right Turn sign shall be placed at the near right-hand corner of the intersection. Where No Left Turn or No Turns signs are re-**

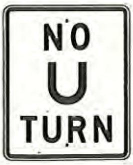
quired, two shall be used, one at the near right-hand corner and one at the far left-hand corner, facing traffic approaching the intersection. Where there is a traffic signal on the far right corner, the sign on the right-hand side shall be placed near that signal.



R3–1
24″ x 30″



R3–3
24″ x 24″



R3–4
24″ x 30″

These are minimum requirements, and additional signs should be placed as necessary at or in advance of the intersection. Overhead signs are sometimes desirable, particularly in congested areas. Signs may be mounted just above, below, or alongside traffic signal faces governing the traffic to which they apply. If advance signs are used, care should be taken that no alley or public driveway exists between them and the intersection where the turning movement is prohibited. At an intersection with a one-way street, whether signalized or not, the One Way sign (sec. 1B–28) should be used, and may be supplemented by the Turn Prohibition sign (fig. 1–3). A Turn Prohibition sign is not needed at a ramp entrance to an expressway where the design is such as to indicate clearly the one-way traffic movement on the ramp.

A Turn Prohibition sign mounted on a traffic signal installed directly over any roadway shall have a clearance of at least 15 feet above the roadway.

When the movement restriction applies during certain periods only, the use of Turn Prohibition signs calls for special treatment. The following alternatives are listed in order of preference:

1. Internally illuminated signs that are lighted and made legible only during the restricted hours, particularly desirable at signalized intersections.
2. Permanently mounted signs incorporating a supplementary legend showing the hours during which the prohibition is applicable.
3. Movable signs at each corner of the intersection where required, put in place under police supervision only when applicable and removed at other hours.

1B–17 U-Turn Prohibition Sign (R3–4)

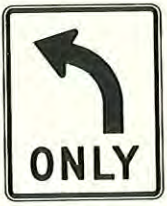
The NO U TURN sign may be used at or between intersections to indicate regulations prohibiting U turns at or on the specific intersections or roadways so posted. **It shall have a standard size of 24 inches by 30 inches, and a small size of 18 inches by 24 inches for secondary city streets.**

This sign may be used also on expressways where a crossover between roadways has been provided for official or emergency use only. It should be erected to the left of the roadway immediately in advance of the crossover. On expressways the sign should be at least 36 inches by 48 inches in size.

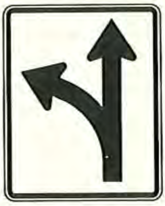
> *Interstate.*—On the Interstate System it is prescribed that this sign shall be 36 inches by 48 inches in size, that it shall be used only when required by State law, and that it shall be placed parallel to the highway. Where the sign is not used a double yellow delineator-type reflector marker (sec. 2D–4) shall be placed at the left of the roadway, on the far side of the crossover.

1B–18 Lane-Use Control Signs (R3–5 to 8, inclusive)

Lane-Use Control signs shall be used to indicate the types of movement that are permitted or required from specific lanes at an intersection. The standard, and minimum, sizes of these signs shall be 30 inches by 36 inches for the overhead signs and 30 inches by 30 inches for the post-mounted signs. The signs for overhead mounting (R3–5 and R3–6) shall be mounted over the lanes to which they apply. The mandatory movement sign (R3–5) shall show a single arrow and the regulatory word message ONLY. The optional movement sign (R3–6) shall show a straight-through and a curved arrow with the lower ends of their shafts superimposed, to indicate that either of the movements symbolized is permissible.

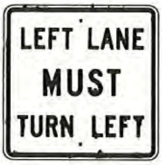


R3–5
30" x 36"

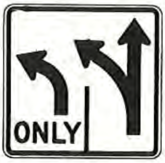


R3–6
30" x 36"

The mandatory turn sign (R3–7) designed for post mounting shall carry the message RIGHT (or LEFT) LANE MUST TURN RIGHT (or LEFT).



R3–7
30" x 30"



R3–8
30" x 30"

Double-turn signs for post mounting may be needed at such locations as at the right curb (for double right turns) or on the left side of a one-way street or on the median of a divided highway (for double left turns). The post-mounted double-turn signs (R3–8) should carry, side by side, on the same plate, two arrow symbols similar to the designs for the overhead signs.

1B–19 Warrants for Lane-Use Control Signs

Lane-Use Control signs at intersections shall be used whenever it is desired to require vehicles in certain lanes to turn, or to permit turns from an adjacent lane.

The Uniform Vehicle Code (sec. 11–601) authorizes such changes from normal turning regulations.

Lane-use controls permitting left (or right) turns from two (or more) lanes are normally warranted whenever the turning volume exceeds the capacity of one turning lane, and when all movements can be accommodated in the lanes available to them.

When multiple-lane left turns are to be permitted at signalized intersections, special signal phasing should be used to allow the turning movements without interference from opposing or cross traffic.

1B–20 Location of Lane-Use Control Signs

Overhead Lane-Use Control signs are preferred because they can be placed over the lanes to which they apply. This type of control, and particularly the multiple-lane turn, occurs where volumes are high and an overhead installation can be justified.

When post-mounted Lane-Use Control signs are used, one sign should be placed at the intersection. A second Lane-Use Control sign should be placed at an adequate distance in advance of the intersection so that motorists can select the appropriate lane before reaching the ends of the lines of waiting vehicles. Supplementary pavement markings (sec. 2B–26) should be used with post-mounted signs.

Post-mounted signs shall be sufficiently high (at least 8 feet above the pavement surface) to make them visible to motorists traveling in lanes other than the median or curb lane.

1B–21 Do Not Pass Sign (R4–1)

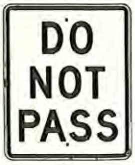
The DO NOT PASS sign may be used on a two- or three-lane road at the beginning of, and at intervals within, a zone through which restricted sight distance or other condition makes overtaking and passing hazardous. The sign is normally used in addition to standard pavement markings (sec. 2B–8) to emphasize the restriction on passing. Where pavement markings are present the sign need not be used.

The standard Do Not Pass sign shall be 24 inches by 30 inches in size, with a minimum size for minor roads of 18 inches by 24 inches. It shall be erected in accordance with the general specifications for sign placement (secs. 1A–22, 23).

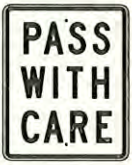
Because a driver about to pass a vehicle ahead often has only a restricted view to the right, an additional sign on the left-hand side of the roadway may be desirable.

Standards for determining the location and extent of no-passing zones are set forth in connection with pavement markings through such zones (secs. 2B–9, 10).

No-passing zones are not required on expressways with divided roadways.



R4–1
24" x 30"



R4–2
24" x 30"

1B–22 Pass With Care Sign (R4–2)

The PASS WITH CARE sign shall be used at the end of a no-passing zone where a Do Not Pass sign has been erected at the beginning of the zone. It shall be of the same size, and shall be erected in the same manner as the Do Not Pass sign.

1B–23 Slower Traffic Keep Right Sign (R4–3)

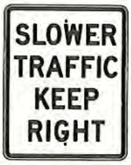
The SLOWER TRAFFIC KEEP RIGHT sign shall have a standard, and minimum, size of 24 inches by 30 inches. Because it will not be used on secondary roads, no small design is provided for. On expressways the sign should be at least 36 inches by 48 inches in size.

The sign shall be erected in accordance with the general requirements for sign placement (secs. 1A–22, 23).

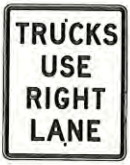
The Slower Traffic Keep Right sign may be used on multiple-lane roadways where it is desirable to keep traffic from unnecessary weaving. It should be erected just beyond the beginning of a multiple-lane pavement, and at other locations where there is a tendency on the part of the motorist to drive in the left-hand lane (or lanes) below the normal speed of traffic. It should not be used on the approach to an interchange.

An alternative legend for this sign, KEEP RIGHT EXCEPT TO PASS, (R4–4) may be used where State law requires vehicles to keep in the right-hand lane at all times except when overtaking and passing. Because freeway traffic can move more effectively if vehicles are not required to weave from side to side unnecessarily, the SLOWER TRAFFIC KEEP RIGHT is preferable where it can legally be used.

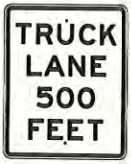
> *Interstate.*—Standards for the Interstate System prescribe use of the Keep Right Except to Pass sign, with the Slower Traffic Keep Right sign as a permitted alternate to it. In either case, the sign is 48 inches by 60 inches in size.



R4–3
24" x 30"



R4–5
24" x 30"



R4–6
24" x 30"

1B–24 Signs for Uphill Traffic Lanes (R4–5, R4–6)

Where an extra lane has been provided on an upgrade for slow-moving traffic, it shall be preceded by a sign directing such traffic into this "climbing" lane. The Slower Traffic Keep Right sign (sec. 1B–23) is applicable to this purpose, or more specific messages such as TRUCKS USE RIGHT LANE (R4–5) may be used. **The standard, and minimum, size of these signs shall be 24 inches by 30 inches.**

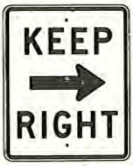
In advance of the beginning of the climbing lane a sign, TRUCK LANE (500) FEET (R4–6), may be erected, of the same size as the sign at the beginning of the climbing lane. The distance shown should approximate that of the actual location of the sign.

In advance of the end of the climbing lane, a Pavement Width Transition warning sign shall be erected (sec. 1C–18). This is particularly important, as the end of the climbing lane will normally be concealed beyond the crest of the grade. A duplicate sign on the left of the roadway is also desirable to warn the faster traffic, as the sign on the right may be obscured by the slower moving trucks.

Pavement markings should clearly indicate that the climbing lane is an additional lane in one direction, and that the section is not to be used as a three-lane road (sec. 2B–15).

1B–25 Keep Right Sign (R4–7)

The KEEP RIGHT sign shall have a standard size of 24 inches by 30 inches, and a small size of 18 inches by 24 inches for minor roads and secondary streets. On expressways the sign should be at least 36 inches by 48 inches.



R4–7
24" x 30"

The arrow is normally horizontal, but where traffic is not required to turn sharply an arrow pointed upward at an angle of about 30 degrees (R4–8) may convey its message more clearly.

The Keep Right sign shall be used within and at the ends of medians, parkways, loading islands, and refuge islands, at traffic islands, and at underpass piers, where traffic is required to keep to the right of such obstructions.

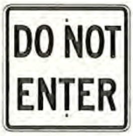
Where the obstruction is in or so near the line of traffic that the sign at a normal minimum height may be obscured by vehicles, a second sign of the same design may be mounted directly above the standard sign with its bottom edge at a height of 8 to 10 feet above the pavement. In this case the lower sign may be placed somewhat below the normal minimum height.

On a median the Keep Right sign should be mounted not more than 50 feet beyond the approach end of the island. On a pedestrian island or intersection channelizing island it should be mounted at the approach end or as close thereto as practicable. The sign should be mounted on the face of or just in front of a pier or other obstruction in the center of the roadway, in which case the standard stripe markings on the obstruction (sec. 2C–2) should be discontinued to leave a 3-inch space around the outside of the sign, as shown in figure 2–19.

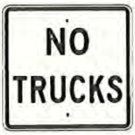
Where traffic is permitted to pass to either side of an island or other obstruction in the roadway, the Double-Arrow warning sign should be used (sec. 1C–34).

1B–26 Do Not Enter Sign (R5–1)

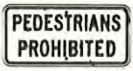
The standard, and minimum, size of the DO NOT ENTER sign shall be 24 inches square. It shall be conspicuously placed in the most appropriate position at the end of a one-way roadway or ramp to prohibit traffic from entering the restricted section. It should normally be mounted on the right-hand side of the roadway, facing traffic entering the roadway or ramp in the wrong direction. A second sign on the left-hand side of the roadway may be justified, particularly where traffic may be approaching in a turn (fig. 1–3). **The sign shall be erected in accordance with the general requirements for sign placement (secs. 1A–22, 23).**



R5–1
24" x 24"



R5–2
24" x 24"



R5–3
24" x 12"

1B–27 Selective Exclusion Signs

The laws of some States permit the State or local authority having jurisdiction to exclude trucks or other commercial vehicles from any designated highway where signs have been placed giving notice thereof. These signs have not been standardized, but NO TRUCKS (R5–2), TRUCKS EXCLUDED, and COMMERCIAL VEHICLES EXCLUDED are suggested as suitably brief and specific messages.

It is similarly provided in some States that the proper authority may exclude pedestrians, bicycles, or other nonmotorized traffic from controlled-access roadways and shall erect signs setting forth such restrictions. Such signs may clearly indicate the type of traffic that is admitted or the type that is excluded.

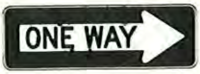
A suitable model for exclusion legislation may be found in the Uniform Vehicle Code (secs. 11–313 and 14–113).

Because of the variety of possible messages for these signs, it is not practicable to fix standard sizes for them as a class. In all cases the lettering should be large enough to give adequate legibility. **They shall be conspicuously placed, in accordance with the general requirements for sign placement (secs. 1A–22, 23) at all entrances to the restricted roadway.**

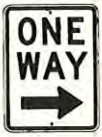
Where an unrestricted roadway intersects the restricted roadway the Exclusion sign should be placed on the right-hand side of the restricted roadway approximately 25 feet from the intersection so as to be clearly visible to all drivers and others turning into the restricted roadway. A supplementary sign may be necessary on the left-hand side of the restricted roadway.

High-speed expressways with widely spaced access points are neither safe nor practical for pedestrian traffic. Except where sidewalks are provided, therefore, pedestrians will normally be excluded. A PEDESTRIANS PROHIBITED sign (R5–3) should be used at interchanges or elsewhere where pedestrians can enter the expressway right-of-way and endanger themselves or others, particularly where they attempt to cross the roadways. The sign may also be used at underpasses or elsewhere where safe pedestrian facilities are not provided. The sign should be erected wherever it can be most effective. Because of the length of the words constituting its legend, a horizontal panel is warranted, 24 inches by 12 inches in size. As an exception to the general rule, it need not be reflectorized or illuminated.

If an exclusion is to be governed by vehicle weight, a Weight Limit sign (sec. 1B–40) rather than an Exclusion sign should be used.



R6–1
36" x 12"



R6–2
18" x 24"

1B–28 One Way Sign (R6–1, R6–2)

The ONE WAY sign shall be used to indicate streets or roadways upon which vehicular traffic is allowed to travel in one direction only. The sign shall be either (a) a white arrow on a black horizontal rectangle of a standard, and minimum, size of 36 inches by 12 inches, with the words ONE WAY centered in the arrow (R6–1); or (b) a vertical rectangle of a standard, and minimum, size of 18 inches by 24 inches, with black lettering and

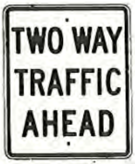
arrow on a white background (R6–2). The vertical design has advantages where lateral space is limited. Both designs must be made in rights and lefts.

One Way signs shall be placed on the near right-hand and the far left-hand corners of the intersection so as to face traffic entering or crossing the one-way street (fig. 1–3). Where the intersection is signalized, the signs shall be placed near the appropriate signal faces. One Way signs shall also be placed parallel to the one-way street directly opposite the exits from alleys and other public ways. A One Way sign should always be used, where applicable, and may be supplemented by a Turn Prohibition sign (sec. 1B–16).

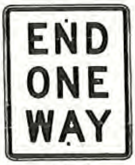
One Way signs are not ordinarily needed on the one-way roadways of divided expressways, where the design of interchanges indicates the direction of traffic on the separate roadways.

1B–29 Reversible Flow and Periodic One-Way Signs

To a growing extent traffic capacity of city streets is being increased by reversing the direction of travel in certain lanes at certain times of day, or by putting the entire street under one-way operation during certain hours, sometimes in different directions at different times of day. Standard signs applicable to such conditions have not been developed, but experimentation and research is widespread, and the National Joint Committee on Uniform Traffic Control Devices expects to recommend suitable standards as soon as satisfactory techniques have been found acceptable.



R6–3
24" x 30"



R6–4
24" x 30"

1B–30 One Way Transition Signs (R6–3, R6–4)

Appropriate transition signs shall be used on a one-way street or roadway in advance of an intersection or the end of a divided roadway beyond which the one-way traffic regulation does not apply. Either of two standard designs may be used. **The first design shall carry the legend TWO WAY TRAFFIC AHEAD (R6–3) and the alternate legend shall be END ONE WAY (R6–4). Both signs shall have a standard, and minimum, size of 24 inches by 30 inches.**

These signs shall be placed on both the right-hand and left-

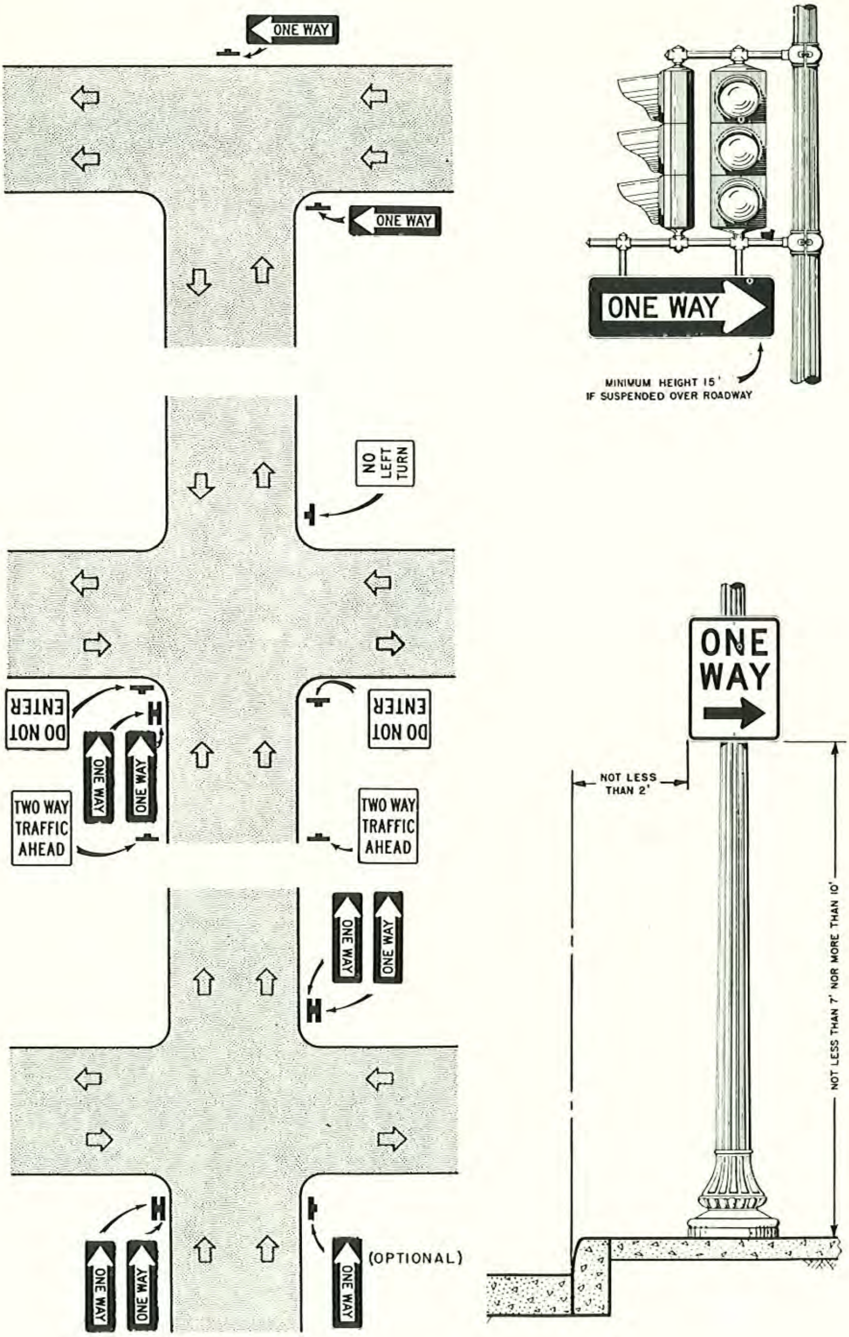

ONE WAY
ONE WAY
ONE WAY
MINIMUM HEIGHT 15'
IF SUSPENDED OVER ROADWAY
NO LEFT TURN
DO NOT ENTER
ONE WAY
ONE WAY
DO NOT ENTER
TWO WAY TRAFFIC AHEAD
TWO WAY TRAFFIC AHEAD
ONE WAY
ONE WAY
ONE WAY
NOT LESS THAN 2'
NOT LESS THAN 7' NOR MORE THAN 10'
ONE WAY
ONE WAY
ONE WAY
(OPTIONAL)

Figure 1–3. Location of One Way signs.

hand sides of the street or roadway at an appropriate distance, depending on approach speeds and type of facility, from the intersection where two-way traffic is resumed (fig. 1–3). For an advance warning, the End One Way sign may be placed some distance in advance of the intersection, with a supplementary legend, or separate plate, reading 500 FEET or other appropriate distance.

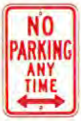
These signs should not be used on a one-way connecting ramp or at a T intersection where a one-way street ends.

1B–31 Parking and Stopping Signs (R7 series)

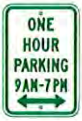
Parking signs and other signs governing the stopping and standing of vehicles cover a very wide variety of regulations and only general specifications can be laid down here. Typical examples are as follows:

NO PARKING ANY TIME (R7–1)
NO PARKING 8:30 A M TO 5:30 P M (R7–2)
NO PARKING EXCEPT SUNDAYS AND HOLIDAYS (R7–3)
NO STOPPING OR STANDING (R7–4)
ONE HOUR PARKING 9 A M–7 P M (R7–5)
NO PARKING LOADING ZONE (R7–6)
NO PARKING BUS STOP (R7–7)

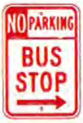
Many other wordings will be found necessary to fit local conditions.



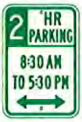
R7–1
12″ x 18″



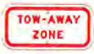
R7–5
12″ x 18″



R7–107
12″ x 18″



R7–108
12″ x 18″



R7–201
12″ x 6″

The legend on parking signs shall state whatever regulations apply, but the signs shall conform to the standards of shape, color, location, and use. Generally, parking signs should display such of the following information as is appropriate, from top to bottom of the sign, in the order listed:

1. Restriction or prohibition.
2. Time of day it is applicable, if not at all hours.
3. Days of week applicable, if not every day.

In addition there should be a single-headed arrow pointing in the direction the regulation is in effect if the sign is at the end of a zone, or a double-headed arrow pointing both ways if the sign is at an intermediate point in a zone.

As an alternate to the arrow, if the signs are posted facing traffic at an angle of 90 degrees to the curb line, there may be included on the sign, or on a separate plate below the sign, such legend as HERE TO CORNER, THIS SIDE OF SIGN, or BETWEEN SIGNS.

Where parking is prohibited at all times or at specified times, parking signs shall have red letters and border on a white background (Parking Prohibition signs); and where only limited-time parking is permitted, or where parking is permitted only in a particular manner, the signs shall have green letters and borders (Parking Restriction signs).

For emphasis the word NO or the numeral showing the time limit in hours or minutes may be in a reversed color arrangement in the upper left-hand corner of the sign, i.e., in white on a rectangular area of red or green (R7–107, 108).

Where parking is prohibited during certain hours and permitted under a time limit at other periods of the day, two parking signs should ordinarily be used, the red above the green. As an alternative both messages, in different colors, may be used on a single plate, with the sign lengthened vertically if necessary.

On urban streets parking signs shall have a standard, and minimum, size of 12 inches by 18 inches. Special parking signs (sec. 1B–33) should be used on rural roads and expressways.

At the transition point between two parking zones it may be advantageous to use, instead of two signs, a single sign 20 inches by 18 inches. This is in effect two standard signs mounted side by side. Such a sign should display a right and a left arrow pointing in the directions that the respective restrictions apply.

Where it is essential that all traffic lanes be kept open for moving traffic, some city authorities make it a practice to tow away illegally parked vehicles. To make the parking regulations more effective, and to improve public relations by giving a definite warning, a sign reading TOW-AWAY ZONE (R7–201) may be appended to, or incorporated in, any parking prohibition sign. It should have red legend on a white background.

1B–32 Placement of Parking Signs

Parking signs in residence and business districts shall be mounted not less than 7 feet nor more than 10 feet above the top of the curb, and with no part of the sign less than 2 feet back from the face of the curb. Where space is limited, or existing poles are close to the curb, a lesser lateral clearance is permissible (sec. 1A–23). If arrows are used to indicate the extent of the restricted zones, the signs should be set at an angle of not less than 30 degrees nor more than 45 degrees with a line parallel to the flow of traffic so as to be visible to approaching traffic.

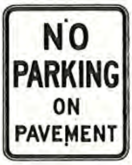
Care should be exercised to see that the single arrows point in the proper direction to indicate the regulated zone. Where the zone is longer than 200 feet, signs showing a double arrow will be needed at intermediate points within the zone, at intervals not exceeding 200 feet.

If the signs are mounted at an angle of 90 degrees to the curb line, two signs must be mounted back to back at the transition point between two parking zones, each with the appended plate reading THIS SIDE OF SIGN. At intermediate points within a zone a single sign without any arrow or appended plate should be used, facing in the direction of approaching traffic. Otherwise the standards of placement should be the same as for signs using directional arrows.

1B–33 Parking Signs in Rural Districts (R8 series)

In rural districts special parking prohibition signs may be necessary to emphasize the provisions of law that no person shall stop, park, or leave standing any vehicle on the paved or traveled part of the highway where it is practical to leave such vehicle off such part of the highway. The signs should be used primarily at points of scenic beauty or other points of interest where violations are prevalent, and where stopping or parking on the pavement obstructs the normal flow of traffic.

The legend on rural parking signs must be appropriate to the restrictions imposed. The legend NO PARKING ON PAVEMENT (R8–1) is generally suitable, except where a roadway has paved shoulders, in which case NO PARKING EXCEPT ON SHOULDER (R8–2) is less likely to cause confusion. If necessary the word STOPPING may be substituted for PARKING. To prohibit any parking the simple legend NO PARKING (R8–3) is suitable.



R8–1
24" x 30"

On expressways the stopping of vehicles not only can cause an undesirable interference with free movement, but can be exceedingly hazardous. If an emergency stop is necessary it should be made on the shoulder, well off the pavement. Even parking on the shoulder, however, can be dangerous, especially during the accompanying procedures of driving off the road or back onto it. Except where adequate paved turnouts are provided, the road shoulders should be reserved only for emergency use by vehicles that must leave the roadway to stop because of mechanical breakdown, tire trouble, lack of fuel, or other emergencies involving the vehicles or their occupants.

The EMERGENCY PARKING ONLY sign (R8–4) may be used a short distance beyond an interchange entrance and at random intervals as needed, particularly where scenic or other attractions create a tendency to stop temporarily, and no turnouts or rest areas have been provided.

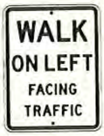
The standard size for rural parking signs shall be 24 inches by 30 inches. On secondary roads a smaller size of 18 inches by 24 inches is permitted. Expressway parking signs should be at least 36 inches by 48 inches.

> *Interstate.*—Parking signs prescribed for the Interstate System include only the legends EMERGENCY PARKING ONLY and EMERGENCY STOPPING ONLY. For these signs a horizontal rectangle in a size of 48 inches by 36 inches is prescribed.

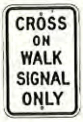
Rural parking signs shall be erected in accordance with the general requirements for sign placement (secs. 1A–22, 23).

1B–34 Walk on Left Sign (R9–1)

The pedestrian sign WALK ON LEFT FACING TRAFFIC may be used to encourage safer pedestrian habits on rural highways where no sidewalks are provided. **This sign shall be in only one standard size of 18 inches by 24 inches.** It should be erected on the right-hand side of the road where pedestrians must walk on the pavement or road shoulder in the absence of pedestrian pathways or sidewalks.



R9–1
18" x 24"



R9–3
12" x 18"

1B–35 Pedestrian Crossing Signs (R9–2 to R9–5)

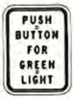
Pedestrian Crossing signs may be used to supplement traffic-signal control, or to aid in limiting pedestrian crossing to safe places. They will ordinarily be required only in business districts or at signalized intersections. The following messages are typical:

CROSS ON GREEN LIGHT ONLY (R9–2).
CROSS ON WALK SIGNAL ONLY (R9–3).
CROSS ONLY AT CROSS WALKS (R9–4).
NO PEDESTRIAN CROSSING (R9–5).

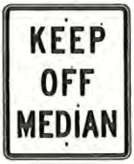
Pedestrian Crossing signs shall have a standard size of 12 inches by 18 inches. They shall be erected to face pedestrians about to cross the roadway.

1B–36 Pedestrian-Actuated Signal Sign (R9–6, R9–7)

The Pedestrian-Actuated Signal sign should be used where it is desired to enforce pedestrian observance of traffic-actuated signals. To permit pedestrians to register a demand for the Go signal, a pedestrian pushbutton should be conveniently mounted on a post at each end of each crosswalk controlled by the traffic-actuated signals. Such a pushbutton should be at a height of from 3½ to 4 feet above the sidewalk, and the Pedestrian Actuated Signal sign, reading PUSH BUTTON FOR GREEN LIGHT (R9–6) or PUSH BUTTON FOR WALK SIGNAL (R9–7), should be mounted immediately above it. **The sign shall be 9 inches by 12 inches in size.**



R9–6
9" x 12"



R10–1
24" x 30"

1B–37 Keep Off Median Sign (R10–1)

On divided roadways having no physical barrier between the separated roadways, drivers often attempt to cross the median, particularly where such crossing offers an opportunity to correct for having made an error in choice of direction at an intersection or interchange. A median also may be an inviting place to park. On a high-speed expressway these practices can be dangerous and should be prohibited.

The KEEP OFF MEDIAN sign shall have a standard, and minimum, size of 24 inches by 30 inches. On expressways it should be at least 36 inches by 48 inches.

The sign should be erected on the left of the roadway within the median wherever there is a tendency for drivers to enter or cross and at random intervals as needed.

Interstate.—This sign, in a size of 48 inches by 60 inches, is prescribed for the Interstate System.

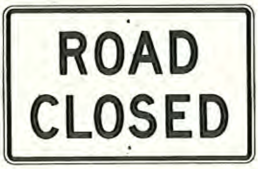
1B–38 Road Closed Sign (R10–2)

The ROAD CLOSED sign shall be used to mark roads that have been closed to all traffic (except the contractor's equipment and other authorized vehicles) either because of construction or maintenance operations or because of a temporary emergency such as high water or a landslide. It should not be used where traffic is maintained or where a route is detoured several miles in advance of the actual construction or blockade. In the latter case the Local Traffic Only sign (sec. 1B–39) should be used.

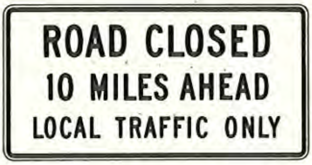
The Road Closed sign shall have a standard, and minimum, size of 48 inches by 30 inches.

At construction operations the sign should be mounted on a Class I barricade (sec. 5C–3) in or near the center of the roadway, at a height of 5 feet to the bottom of the sign. For temporary emergencies it may be erected at the roadside, as close as practical to the pavement edge. If a temporary or detour route begins at a barricade, a Temporary Route assembly (sec. 1D–19) with a directional arrow (sec. 1D–16) or a Detour Arrow sign (sec. 5B–39) should be erected on or in advance of the barricade, wherever it will be most effective. The Detour Arrow sign is usually placed just below the Road Closed sign.

Where the sign faces through traffic, it shall be preceded by an Advance Road Closed warning sign (sec. 5B–21) and, if applicable, an Advance Detour warning sign (sec. 5B–20).



R10–2
48" x 30"



R10–3
60" x 30"

IB–39 Local Traffic Only Sign (R10–3)

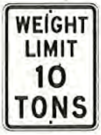
The Local Traffic Only sign shall be used where through traffic must detour to avoid a closing of the highway for construction or maintenance work, or for some temporary emergency, some distance beyond, but where the highway is open for traffic up to the point of closure. It shall carry the legend ROAD CLOSED (10) MILES AHEAD—LOCAL TRAFFIC ONLY. It shall have a

standard, and minimum, size of 60 inches by 30 inches.

It should be erected at the right of the roadway or, preferably, on a narrow barricade in the center of the roadway, if pavement width permits. Normally it will be accompanied by a Temporary Route assembly (sec. 1D–19) with a directional arrow (sec. 1D–16) or a Detour Arrow sign (sec. 5B–39) indicating the proper route for through traffic. The words BRIDGE OUT (or similar message) may be substituted for ROAD CLOSED where applicable. **Where the sign faces through traffic, it shall be preceded by an Advance Road Closed warning sign (sec. 5B–21) with the secondary legend AHEAD and, if applicable, an Advance Detour warning sign (sec. 5B–20).**

1B–40 Weight Limit Sign (R10–4, R10–5)

Due to seasonal weakening of the road surface, obsolescence of bridges or pavements, or other impairment of a roadway, it is often necessary to limit the load permitted on a roadway. **The Weight Limit sign, carrying the legend WEIGHT LIMIT (10) TONS, shall be used to indicate such restrictions. The sign shall have a standard, and minimum, size of 18 inches by 24 inches.**



R10–4
18" x 24"

It shall be located immediately in advance of the section of highway or the structure to which it applies. In the case of an extended length of restricted road, it shall be placed on the right-hand side of the restricted roadway approximately 25 feet from any intersected road on which the restriction does not apply, so as to be clearly visible from all vehicles turning into the restricted roadway. A supplementary sign may be necessary on the left-hand side of the roadway.

Where the restriction applies to axle weight rather than gross load the legend shall be AXLE WEIGHT LIMIT (5) TONS (R10–5).

Weight Limit signs shall be erected in accordance with the general requirements for sign placement (secs. 1A–22, 23).

1B–41 Other Regulatory Signs

Regulatory signs other than those specified above may be required to aid the enforcement of other laws or regulations.

They should be of adequate size, and designed with black lettering on a white background (except large signs, which may have a black background, as provided in sec. 1A–11), on rectangular plates with the longer dimension vertical. They should be mounted in accordance with the general requirements for sign position (secs. 1A–22, 23), or as necessary to make them most effective.

Typical miscellaneous regulatory signs are KEEP OFF WET PAINT, TRACTORS WITH LUGS PROHIBITED, NO DUMPING ALLOWED, NO HITCH HIKING, DO NOT THROW LITTER, and NO FISHING FROM BRIDGE. The uses for such signs are sufficiently obvious to require no detailed specifications.

C—WARNING SIGNS

Section 1C–1 Application of Warning Signs

Warning signs shall be used for the purpose of warning traffic of existing or potentially hazardous conditions either on or adjacent to the road. Warning signs require caution on the part of the motorist and may call for reduction of speed or other maneuver in the interest of his own safety and that of other motorists and pedestrians. Adequate warnings are of great assistance to the vehicle operator and are valuable in safeguarding and expediting traffic. However, the use of warning signs should be kept to a minimum. Too frequent use of them or their unnecessary use to warn of conditions which are apparent tends to breed disrespect for all signs. Improved highway design generally reduces the need for warning signs.

Even on the most modern expressways, however, there will be some conditions to which the motor-vehicle driver must be specially alerted by means of warning signs. These conditions are in varying degree common to all highways, and existing standards for warning signs are generally applicable to expressways.

Typical locations and hazards that may warrant the use of warning signs are:

1. Changes in horizontal alinement (secs. 1C–4 to 9).
2. Intersections (secs. 1C–10 to 13).
3. Advance warning of control devices (secs. 1C–14 to 16).
4. Converging traffic lanes (secs. 1C–17, 18).
5. Narrow roadways (secs. 1C–19 to 21).
6. Changes in highway design (secs. 1C–22, 23).
7. Grades (sec. 1C–24).
8. Roadway surface conditions (secs. 1C–25 to 29).
9. Schools (sec. 1C–30).

10. Railroad crossings (secs. 1C–31, 32).
11. Entrances and crossings (sec. 1C–33).
12. Miscellaneous (secs. 1C–34, 35, 37).

The Advisory Speed plate (sec. 1C–36), used only to supplement one of the other standard warning signs, is in a special category as to design and application, as is the Traffic Signal Speed sign in relation to traffic signals.

Special warning signs at highway construction and maintenance sites are dealt with in part V (secs. 5B–14 to 34)

Determination of the sign to be erected shall be in accordance with the criteria set forth in the following pages. When doubt exists as to which sign to use, the one requiring the minimum restriction shall be erected.

Warning signs specified herein cover most conditions that are likely to be met. **If other warnings are needed, the signs shall be of standard shape and color for warning signs, and the legends shall be brief and simple.**

1C–2 Design of Warning Signs

All warning signs, with the exception of the railroad crossing signs, the Large Arrow signs, and the Advisory Speed plate, shall be diamond-shaped (square with one diagonal vertical) and shall have a "Highway Yellow" background with black legend. Certain exceptions to the diamond shape are provided for in the case of temporary signs for highway construction and maintenance (part V).

All warning signs having significance during the hours of darkness shall be reflectorized or illuminated.

The standard size for each warning sign prescribed herein is shown with the illustration accompanying the specification. **The standard size for diamond-shaped signs, except where otherwise specified, shall be 30 inches by 30 inches.** Where conditions of speed, volume, or special hazard require greater visibility or emphasis, larger signs should be used, with symbol or legend enlarged approximately in proportion to outside dimensions.

To carry proper emphasis among large signs for other purposes, all warning signs on expressways should be not less than 36 by 36 inches in size, and those carrying word messages preferably not less than 48 by 48 inches. On slow-speed interchange connections with secondary roads the standard size will usually be adequate.

On minor roads and secondary city streets, signs smaller than the standard sizes may be adequate. Under such conditions, except where the standard size is herein specifically indicated as the minimum size, any warning sign may be used with sides 6 inches less than the standard here shown.

To permit the use of standard dies and templates the outside dimensions of warning signs should ordinarily be in multiples of 6 inches. Letter heights should be rounded to the nearest integral inch that will best fit the plate used for legibility and appearance.

1C–3 Placement of Warning Signs

Warning signs shall be erected in accordance with the general requirements for sign position (secs. 1A–22, 23).

Since warning signs are primarily for the protection of the driver who is unacquainted with the road, it is very important that care be given to their locations. In rural areas warning signs should normally be placed about 750 feet in advance of the hazard or condition warned of. On high-speed roads, and particularly on expressways, advance warning distances may have to be as great as 1,500 feet or more. On the other hand, in cities, where speeds are relatively low, the advance distance should be only about 250 feet.

The actual advance warning distance will be determined by two factors, the prevailing speed and the condition warned against. These bear respectively on the time available to the driver to comprehend and react to the message, and the time needed by him to perform any necessary maneuver. Given the same prevailing speed, for example, a Signal Ahead warning sign should be placed farther in advance than a Side Road sign.

The effectiveness of any warning signing should be tested periodically under both day and night conditions.

Figures 1–4 and 1–5 show typical installations of standard warning signs. The placement of temporary warning signs used at highway construction and maintenance sites is covered in part V of this Manual.

1C–4 Turn Sign (W1–1)

The Turn sign showing an arrow bent at a right angle (W1–1, right or left), shall be used to mark curves on which a ball-bank indicator shows banks of 10 degrees or more at a speed of 30 miles per hour. Where a Turn sign is warranted, a Large Arrow sign (sec. 1C–9) shall be used on the outside of the turn. Additional protection may be provided by use of the Advisory Speed plate (sec. 1C–36).

1C–5 Curve Sign (W1–2)

The Curve sign, showing a curved arrow (W1–2, right or left), shall be used to mark a curve where a test with a ball-bank indica-

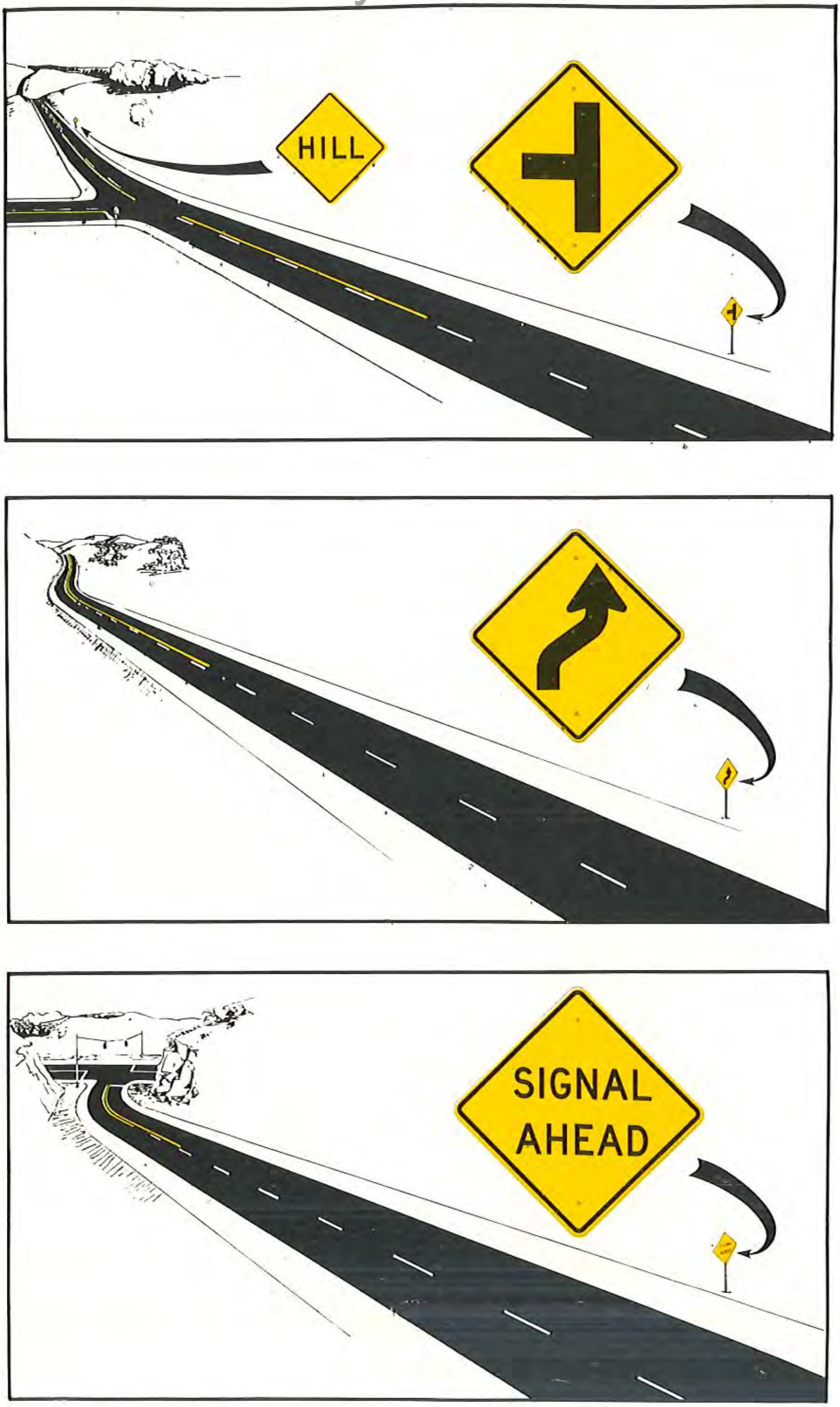

HILL
SIGNAL AHEAD

Figure 1–4. Typical applications of Warning signs.

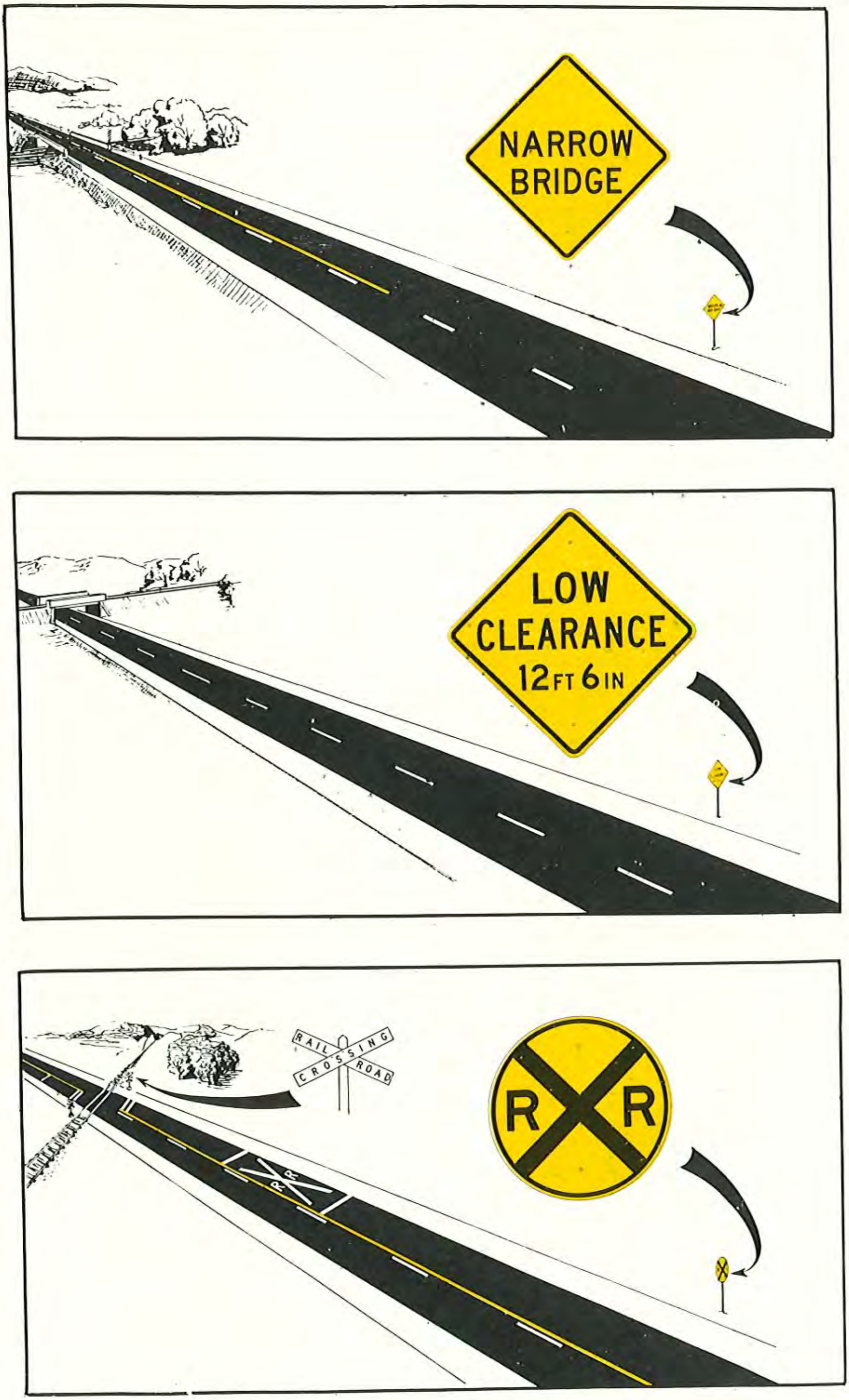
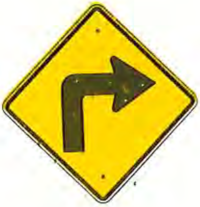
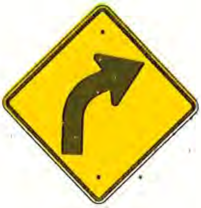

NARROW
BRIDGE
LOW
CLEARANCE
12 FT 6 IN
RAIL ROAD
CROSSING
R R
RXR

Figure 1–5. Typical applications of Warning signs.

tor gives readings of 10 degrees or more at speeds between 30 and 60 miles per hour. Additional protection may be provided by the use of the Advisory Speed plate (sec. 1C–36).



W1–1
30″ x 30″

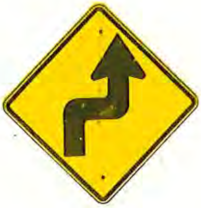


W1–2
30″ x 30″

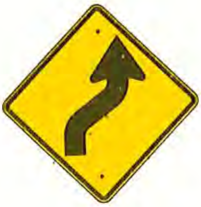
1C–6 Reverse Turn Sign (W1–3)

Where two turns or a curve and a turn in opposite directions, as defined in the warrants for Turn and Curve signs (secs. 1C–4, 5) are separated by a tangent of less than 400 feet, a Reverse Turn sign shall be used, showing an arrow bent twice in opposite directions at right angles. If the first turn is to the right, a Right Reverse Turn sign (W1–3R) shall be used, and if the first turn is to the left, a Left Reverse Turn sign (W1–3L).

For additional protection the Advisory Speed plate (sec. 1C–36) may be used.



W1–3
30″ x 30″



W1–4
30″ x 30″

1C–7 Reverse Curve Sign (W1–4)

Where two curves in opposite directions, as defined in the warrants for Curve signs (sec. 1C–5) are separated by a tangent of less than 400 feet, a Reverse Curve sign shall be used, showing an arrow curved twice in opposite directions. If the first curve is to the right, a Right Reverse Curve sign (W1–4R) shall be used, and if the first curve is to the left, a Left Reverse Curve sign (W1–4L).

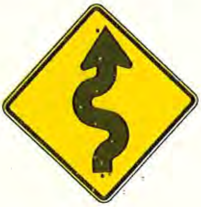
For additional protection the Advisory Speed plate (sec. 1C–36) may be used.

1C–8 Winding Road Sign (W1–5)

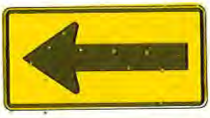
The Winding Road sign showing an arrow bent four times in opposite directions shall be used where there is a series of five or more turns or curves, as defined in the warrants for Turn and Curve signs (secs. 1C–4, 5), separated by tangent distances of less than 400 feet. If the first turn or curve is to the right, a Right Winding Road sign (W1–5R) shall be used, and if the first turn or curve is to the left, a Left Winding Road sign (W1–5L).

The Winding Road sign shall be erected at the beginning of the first curve. In advance of this sign either a Turn or a Curve sign shall be erected showing the direction of the first curve.

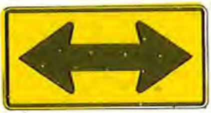
Additional protection may be provided by the installation of road delineation markers (sec. 2D–3), and by use of the Advisory Speed plate (sec. 1C–36). Where there are fewer than five curves in succession, one or more Reverse Turn or Reverse Curve signs should be used.



W1–5
30" x 30"



W1–6
48" x 24"



W1–7
48" x 24"

1C–9 Large Arrow Sign (W1–6, W1–7)

The Large Arrow sign shall be a horizontal rectangle, 48 inches by 24 inches in size, having a large arrow pointing to right or left (W1–6) or to both right and left (W1–7). It shall have a yellow background with symbol in black.

On minor roads and city streets a smaller size of 40 inches by 20 inches, heretofore the standard size, may be used while stocks last.

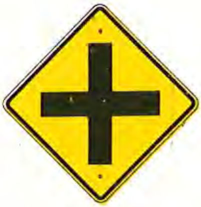
A Large Arrow sign is particularly useful at night to give notice of a sharp change of alinement such as at a curve or turn. It may also, in a single- or double-arrow design, be used at T or Y intersections that have proved hazardous. **The sign shall not be used to mark the ends of median strips, center piers, etc., where there is no change in the direction of travel.**

The Large Arrow sign shall be erected on the outside of a curve or on the far side of an intersection, in line with, and at right angles to, approaching traffic. It should be mounted high enough to be visible for at least 500 feet in advance of the sign. No exact specifications can be given for the placement of this sign. Its location must be checked by trial runs over the road by day and by night.

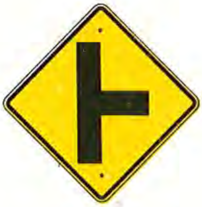
1C–10 Cross Road Sign (W2–1)

The Cross Road sign, showing a vertical cross symbol, shall be erected on a through highway to indicate the presence of a cross road. Its use should be restricted to intersections with roads that are improved to such an extent that there is likely to be a fairly large volume of traffic entering or crossing the through route and where poor sight distance or obscured entrances make it advisable that the intersection be called to the motorist's attention. It should not ordinarily be used where Junction signs (sec. 1D–13) or Advance Turn Arrows (sec. 1D–15) are present. Cross Road signs should not be erected at unimproved intersecting roads. Too frequent use of the Cross Road sign should be avoided.

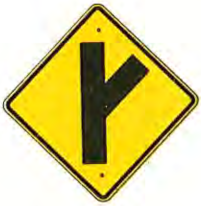
If there is a considerable difference in the importance of the intersecting roads, the more important route may be shown by a heavier line in the diagram. Since this requires the stocking of several different designs, however, and since a turn in a numbered route is shown by Route Turn Assemblies (sec. 1D–15), the use of different widths of line is not mandatory.



W2–1
30" x 30"



W2–2
30" x 30"



W2–3
30" x 30"

1C–11 Side Road Sign (W2–2, W2–3)

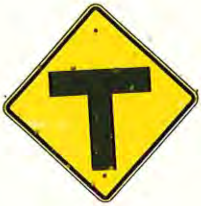
The Side Road sign, showing a side-road symbol, either left or right, and at an angle of either 90 or 45 degrees, shall be used in advance of a side-road intersection according to the same warrants and specifications as set forth for the Cross Road sign (sec. 1C–10).

The relative importance of the intersecting roads may be shown by different widths of line (sec. 1C–10).

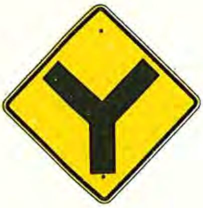
1C–12 T Symbol Sign (W2–4)

The T Symbol sign shall be used to warn traffic approaching a T intersection on the road that forms the stem of the T, i.e., where traffic must make a turn either to the right or to the left. The sign should not generally be used on an approach where traffic is required to stop before entering the intersection, nor at a T intersection that is channelized by traffic islands, nor where Junction signs or Advance Turn Arrows are present.

The relative importance of the intersecting roads may be shown by different widths of line (sec. 1C–10). It may be desirable to place a double-headed Large Arrow sign at the head of the T directly in line with approaching traffic (sec. 1C–9).



W2–4
30" x 30"



W2–5
30" x 30"

1C–13 Y Symbol Sign (W2–5)

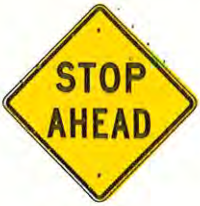
The Y Symbol sign shall be used to warn motorists approaching a Y intersection on the road that forms the stem of the Y. It shall not be used at a Y intersection that is channelized by traffic islands, nor, generally, where Junction signs or Advance Turn Arrows are present.

The relative importance of the intersecting roads may be shown by different widths of line (sec. 1C–10). It may be desirable to erect a double-headed Large Arrow sign (sec. 1C–9) at the fork of the Y directly in line with approaching traffic.

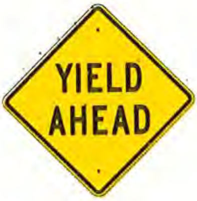
1C–14 Stop Ahead Sign (W3–1)

The STOP AHEAD sign shall be a minimum of 30 inches by 30 inches in size.

The Stop Ahead sign shall be used in advance of a Stop sign (sec. 1B–4) that is not visible for a sufficient distance to permit the driver to bring his vehicle to a stop at the Stop sign. Obstruction of view due to horizontal or vertical curves, parked vehicles, or foliage, and high approach speeds, should be considered in determining the need for the erection of this sign. In some cases it may be used for emphasis where there is poor observance of the Stop sign.



W3-1
30" x 30"



W3-2
30" x 30"

1C-15 Yield Ahead Sign (W3-2)

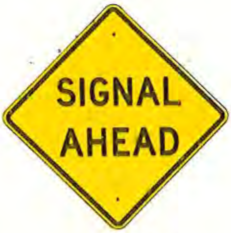
The YIELD AHEAD sign shall be a minimum of 30 inches by 30 inches in size.

The Yield Ahead sign shall be used in advance of a Yield sign (sec. 1B-7) that is not visible for a sufficient distance to permit the driver to bring his vehicle to a stop at the Yield sign. Other considerations for the use of the Yield Ahead sign are the same as those given for the Stop Ahead sign (sec. 1C-14).

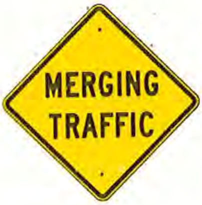
1C-16 Signal Ahead Sign (W3-3)

The SIGNAL AHEAD sign shall be used in advance of any rural signalized intersection where the signal is not visible for a distance of 600 feet in advance of the intersection, or in advance of any signalized intersection where the prevailing approach speeds or conditions of visibility are such as to justify an advance warning.

Use of this sign is warranted where horizontal or vertical curves limit the sight distance on the approach to traffic signals, or where lights or illuminated signs at the intersection may distract the driver's attention from the signal.



W3-3
36" x 36"



W4-1
30" x 30"

1C-17 Merging Traffic Sign (W4-1)

The MERGING TRAFFIC sign should be used just in advance of a point where two roadways converge at a flat angle and no turning conflict occurs, to warn motorists that merging movements may be encountered.

The sign should be erected on the side of the major roadway on which merging traffic will be encountered and in such a position as not to obstruct the driver's view of vehicles on the entering roadway. Ordinarily the motorist on the minor or ramp roadway is aware that he may have to merge with other traffic, but an additional sign may be placed on the entering roadway as a reminder. The sign can sometimes be placed so as to be visible from both roadways, but the motorist on the major roadway should be given the better view. Where two roadways of approximately equal importance converge, a sign should be placed on each roadway.

The Merging Traffic sign should not be used in place of a Pavement Width Transition sign where lines of traffic moving on a single roadway must merge due to a reduction in the actual or usable pavement width (sec. 1C–18).

> *Interstate.*—On the Interstate System it is prescribed that the Merging Traffic sign, 48 inches by 48 inches in size, is to be erected on the appropriate side of the through roadway in advance of where another roadway enters.

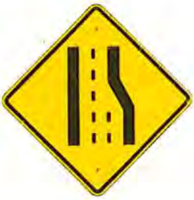
1C–18 Pavement-Width Transition Sign (W4–2)

The Pavement-Width Transition sign shall be used to give advance notice of a reduction in the number of lanes of pavement, as from three lanes to two lanes, or from four lanes to two lanes. Pavement markings and, where applicable, reflector markers shall also be used to mark such transitions (secs. 2B–14, 2D–4).

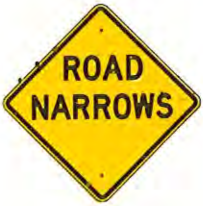
The legend shall consist of a symbol showing the number of lanes in advance of, through, and beyond the transition. A broad line shall show the general configuration of each side of the roadway, and the lane lines shall be represented by short line segments. A no-passing line applying to traffic facing the sign shall be represented by a single solid line. Typical designs and applications are shown in figure 2–4.

On divided highways, where the width of the median island will permit, two such signs shall be placed facing approaching traffic, one on the right side and the other on the median island. In advance of the termination of an uphill climbing lane it is also desirable to place a supplemental sign to the left of the roadway.

This sign shall not be used in advance of the end of an acceleration lane. It should not ordinarily be used in advance of a point where a lane is closed by construction operations, except where the condition will be stable for an appreciable duration. It should not be used alone at construction sites but must be accompanied by standard construction signs as described in part V. Careful supervision is necessary to insure the proper use of this sign.



W4–2
30″ x 30″



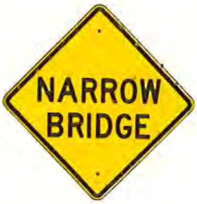
W5–1
30″ x 30″

1C–19 Road Narrows Sign (W5–1)

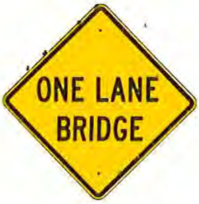
The ROAD NARROWS sign shall be used on two-lane roads where the pavement width is reduced abruptly to a width such that two cars cannot pass safely without reducing speed. It is not warranted on minor roads carrying a low volume of traffic, even though the narrowed pavement is only from 16 to 18 feet in width, but the approach to a reduction in pavement width below 16 feet should always be marked.

1C–20 Narrow Bridge Sign (W5–2)

The NARROW BRIDGE sign shall be used to indicate a bridge having a clear two-way roadway width of 16 to 18 feet, inclusive, or any bridge having a roadway clearance less than the width of the approach pavement. Additional protection may be provided by the use of reflector markers (sec. 2D–2).



W5–2
30″ x 30″



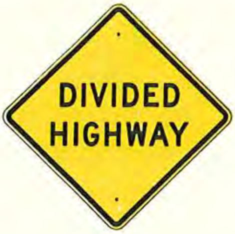
W5–3
30″ x 30″

1C–21 One Lane Bridge Sign (W5–3)

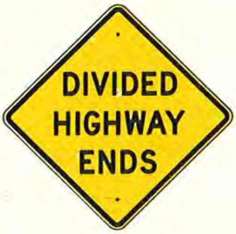
The ONE LANE BRIDGE sign shall be used to mark all two-way bridges having a clear roadway width of less than 16 feet. It may also be used on bridges having roadway widths of less than 18 feet when commercial vehicles constitute a high proportion of the traffic using the structure or when the alinement approaching the structure is poor. Additional protection may be provided by the erection of reflector markers (sec. 2D–2).

1C–22 Divided Highway Sign (W6–1)

The DIVIDED HIGHWAY sign should be used on the approaches to a section of highway where the opposing flows of traffic are separated by a median island.



W6–1
36″ x 36″



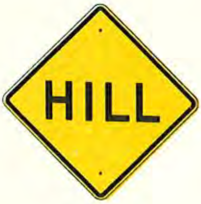
W6–2
36″ x 36″

1C–23 Divided Highway Ends Sign (W6–2)

The DIVIDED HIGHWAY ENDS sign should be used at the end of a section of divided highway as a warning of two-way traffic ahead. The Two-Way Traffic Ahead sign (sec. 1B–30) should be used to give additional warning and notice just in advance of the transition to the two-way section.

1C–24 Hill Sign (W7–1, W7–2)

The HILL sign (W7–1) shall be used in advance of that part of a downgrade where the length, percent of grade, horizontal curvature, or combination thereof, is such as to require special precautions on the part of drivers of any or all vehicles.



W7–1
30″ x 30″

The Hill sign shall be used in advance of downgrades of 6 percent or more for lengths given in the following table, or grades of 6 percent or more where any part of the grade is on a curve sharper

than 4 degrees. Generally, a Hill sign is warranted on descending grades under the following conditions:

On a 6-percent grade more than 2,000 feet long;
on a 7-percent grade more than 1,000 feet long;
on an 8-percent grade more than 750 feet long;
on a 9-percent grade more than 500 feet long;
on an 11-percent grade more than 400 feet long;
on a 13-percent grade more than 300 feet long;
on a 15-percent grade more than 200 feet long;
on a grade of 16 percent or more, of any length.

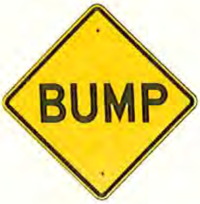
Where conditions may require a descent of the grade in intermediate or low gear, the Oversize Hill sign (W7–2), 48 by 48 inches in size with a secondary message USE SECOND GEAR, USE LOW GEAR, TRUCKS USE LOWER GEARS, or similar warning, may be used.

1C–25 Bump Sign (W8–1)

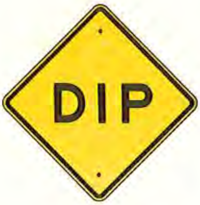
The BUMP sign shall be used to give warning of a sharp rise in the profile of the road that is sufficiently abrupt to create a hazardous condition, to cause considerable discomfort to passengers, to cause a shifting of the cargo, or to deflect a vehicle from its true course, even if such effects are manifested only at speeds 25 percent greater than the normal driving speed for that section of road.

The Bump sign should be used in preference to the Dip sign (sec. 1C–26) where the profile feature is actually a depression (such as a trench or the end of a pavement lift) but where the effect is that of an abrupt jar to the vehicle.

It may be desirable at some locations to supplement the Bump sign with an Advisory Speed plate (sec. 1C–36).



W8–1
30″ x 30″



W8–2
30″ x 30″

1C–26 Dip Sign (W8–2)

The DIP sign shall be used to give warning of a depression in profile that is sufficiently abrupt to create hazards of the type described in connection with the Bump sign (sec. 1C–25). The Dip

sign shall be applicable and used in the same manner as the Bump sign. Use of the Bump sign may be preferable in connection with certain types of depressions (sec. 1C–25).

The Dip sign shall not be used at a short stretch of depressed alinement that may momentarily hide a vehicle. Such a condition should be treated as a no-passing zone (secs. 2B–7 to 2B–10).

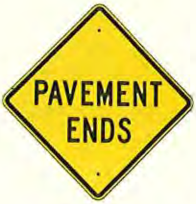
1C–27 Pavement Ends Sign (W8–3)

The PAVEMENT ENDS sign shall be used where a pavement surface changes from a hard-surfaced pavement to a low-type surface or an earth road.

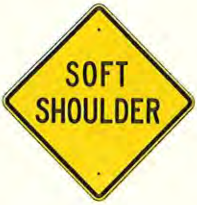
1C–28 Soft Shoulder Sign (W8–4)

The SOFT SHOULDER sign shall be used where a soft shoulder presents a hazard to vehicles that may get off the pavement. This sign will usually be warranted on newly seeded shoulders or on roadways where shoulders are dangerously soft due to weather conditions. The sign should be removed when the hazard no longer exists.

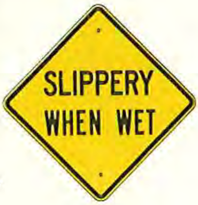
One sign shall be placed at or near the beginning of the soft-shoulder condition, and other signs shall be placed at intervals throughout the length of the road where the condition exists.



W8–3
30″ x 30″



W8–4
30″ x 30″



W8–5
30″ x 30″

1C–29 Slippery When Wet Sign (W8-5)

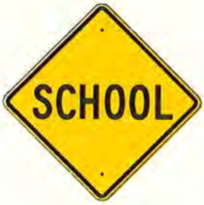
The SLIPPERY WHEN WET sign shall be used to warn traffic of an extraordinarily slippery condition when the pavement is wet. The use of this sign should be kept to an absolute minimum, and upon correction of the slippery condition the sign should be removed.

On rural highways it should be located 500 feet in advance of the beginning of the slippery section and at not greater than 2-mile intervals on long sections of such pavement. In urban districts these distances should be greatly reduced.

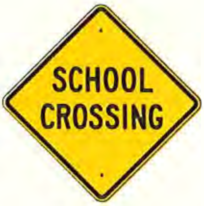
1C–30 School Signs (W9–1, W9–2)

The SCHOOL sign (W9–1) shall be used only at locations where school buildings or grounds are adjacent to the highway and where passing traffic creates a hazard. It shall remain in place during the school season.

The SCHOOL CROSSING sign (W9–2) shall be erected just in advance of an unsignalized crossing used by pupils going to and from school. Only crossings in the vicinity of the school shall be signed.



W9–1
30″ x 30″



W9–2
30″ x 30″

Ordinarily these signs need not be reflectorized, but if there is any considerable use made of the school building at night, it may be desirable to give them adequate nighttime visibility.

For added emphasis, yellow flashing lights may be used in conjunction with the standard school signs, to be operated only during the hours when children are going to or from school.

The crossing should be defined by crosswalk lines (sec. 2B–22).

Portable School signs shall not be placed within the roadway at any time.

1C–31 Railroad Advance Warning Sign (W10–1)

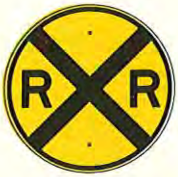
The Railroad Advance Warning sign shall be a yellow disk 36 inches in diameter, carrying a 90-degree crossbuck X and the letters RR in black.

The sign shall be used in advance of every railroad crossing, even if protected by crossbucks, signals, gates, or flagmen, except in the following instances:

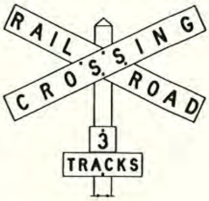
1. At a minor siding or spur which is infrequently used and which is guarded when in use by a member of the train crew.
2. In the business districts of large cities where the crossings are fully protected and the physical conditions are such that even a partially effective display of the sign is impossible.

On a divided highway it may be desirable to erect a supplemental sign on the left of the roadway. In residence or business districts where low speeds are prevalent, the sign may be placed a minimum distance of 100 feet from the crossing. If there is a street intersection within 100 feet, an additional sign or signs should be so placed as to warn traffic approaching the crossing from each intersected street.

Railroad Advance Warning signs are usually off the railroad right-of-way and are properly the responsibility of the public authorities.



W10–1
36" diameter



W10–2

1C–32 Railroad Crossbuck Sign (W10–2)

The crossbuck shall be white with the words RAILROAD CROSSING in black lettering. If there are two or more tracks, including sidings, the number of tracks shall be indicated on an auxiliary sign of inverted T shape mounted below the crossbuck. The crossbuck shall be used at every railroad crossing, alone or in combination with signals or gates.

The design of the commonly used Railroad Crossbuck, with auxiliary sign showing the number of tracks, has been standardized by the Association of American Railroads. Details are shown in *Railroad Highway Grade Crossing Protection,* Bulletin No. 5 (or subsequent issue), Association of American Railroads, Train Operation, Control, and Signals.[7]

The crossbuck sign is usually furnished and installed by the railroad company and is usually located on the railroad right-of-way. The distance that should be assumed to separate tracks before an additional crossing sign is considered necessary is 100 feet, unless local conditions require otherwise.

The sign shall be erected on the right-hand side of the roadway on each approach to the crossing, not more than 15 feet from the centerline of the nearest track. It shall not be less than 6 feet or more than 12 feet from the edge of the pavement, or less than 2 feet outside a paved shoulder or curb. The height should be 10 feet above the level of the highway to the center of the crossbuck, but this may be varied as required by local conditions.

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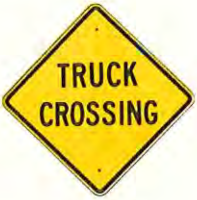
[7] Available from the Association of American Railroads, Transportation Building, Washington 6, D.C.

The practice in some localities of placing the Railroad Crossbuck sign on a pedestal or island in the center of the roadway is strongly disapproved.

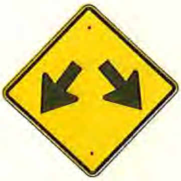
1C–33 Crossing Signs (W11 series)

The Crossing sign, indicating various types of crossings, as TRUCK CROSSING (W11–1), PEDESTRIAN CROSSING (or PED XING), CATTLE CROSSING, DEER CROSSING, or CROSS WALK, shall be used to warn of hazardous crossings of the types indicated. The signs may or may not be of a temporary or seasonal nature, but should be removed if and when the hazardous conditions are terminated.

In many instances it may be desirable to define the crossing by pavement markings (sec. 2B–22).



W11–1
30" x 30"



W12–1
24" x 24"

1C–34 Double Arrow Sign (W12–1)

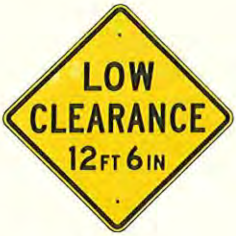
The Double Arrow sign showing two arrows pointing downward to right and left shall be used at loading and refuge islands, traffic islands with curbs more than 3 inches high, and other obstructions in the roadway, where traffic is permitted to pass on either side of the island or obstruction. It shall have a standard, and minimum, size of 24 inches by 24 inches.

The sign should normally be mounted at a height of 7 feet to the bottom of the sign in order that it will be visible over preceding vehicles. On an island it should be mounted at the approach end or as close thereto as practicable. It should be mounted on the face of, or just in front of a pier or other large obstruction, in which case any stripe markings on the obstruction (sec. 2C–2) should be discontinued to leave a 3-inch space around the outside of the sign.

Where traffic must keep to the right of the island or other obstruction, the Keep Right regulatory sign (sec. 1B–25) should be used.

1C–35 Low Clearance Sign (W12–2)

The LOW CLEARANCE sign, indicating low overhead clearance and showing the exact amount of clearance at low bridges, underpasses, and other overhead structures, shall be used at all points where clearance is less than 12 inches greater than the maximum height of vehicle and load permitted under the State law. The actual clearance shall be shown on the sign to the nearest inch. Additional protection should be provided by markings on the structure itself (sec. 2C–2).



W12–2
36" x 36"

Where the clearance is less than the legal limit, a sign to that effect should be placed at the nearest intersecting road or wide point in the road at which a vehicle which may need to can detour or turn around.

In the case of an arch or other structure under which the clearance varies greatly, two or more signs should be used as necessary on the structure itself to give accurate information as to the practical clearance over the entire roadway.

Clearances should be checked periodically, particularly in areas where resurfacing operations have taken place.

1C–36 Advisory Speed Plate (W13–1)

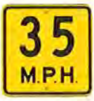
The Advisory Speed plate shall be a square plate of a standard size of 18 inches by 18 inches. When used with a warning sign larger than 36 inches by 36 inches, it shall be 24 inches square.

The plate shall carry the message (35) M.P.H. in black on a yellow background. The speed shown shall be a multiple of 5 miles per hour. The plate may be used in conjunction with any standard yellow warning sign to indicate the maximum safe speed around a curve or through a hazardous location. **It shall not be used in conjunction with any sign other than a warning sign, nor shall it be used alone. When used, it shall be mounted on the same assembly with the standard warning sign, normally below it (fig. 1–1).**

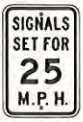
Except in emergencies, or at construction or maintenance sites, where the situation calling for an advisory speed is temporary, an Advisory Speed plate shall not be erected until the safe speed has been determined by accepted traffic engineering procedures. Because changes in surface characteristics, sight distance, etc., may alter the safe speed, each location should be periodically rechecked and the speed plate corrected if necessary.

The Advisory Speed plate is classed with the warning signs because it is, in effect, a part of a warning sign. It is not a regulatory sign, as the speed shown is not intended as an enforceable limit.

> *Interstate.*—For the Interstate System an "Advisory Exit Speed" sign, reading EXIT 30 M.P.H., is prescribed for use where it is necessary to indicate a lower speed on an exit ramp. The sign is 48 inches by 60 inches in size, with black legend on a yellow background. Where an additional advisory speed indication is needed on the ramp well beyond the gore, a standard warning sign with an Advisory Speed plate (W13–1) is to be used.



W13–1
18" x 18"



W13–2
12" x 18"

1C–37 Traffic Signal Speed Sign (W13–2)

The Traffic Signal Speed Sign, reading SIGNALS SET FOR (25) M.P.H., is basically an information sign, though it does not logically fit into any of the general categories of information signs. In previous editions of this Manual it has been classed as a regulatory sign, and it is in accord with the design standards for regulatory signs. Though hardly a warning sign, it is in some ways related to the "advisory speed" signs, and accordingly is here treated in this category.

The sign may be used to indicate the beginning of a section of highway on which the traffic control signals are coordinated into a pretimed progressive system and timed for a specified speed at all hours during which they are operated on a stop-and-go basis. Where used, the sign should be mounted on, or as near as possible, to each signal face where the timed speed changes, and at intervals of several blocks throughout any section where the timed speed remains constant.

1C–38 Other Warning Signs

Warning signs other than those specified above may be required under special conditions. Special expressway design features may warrant the use of individual signs to meet unusual conditions. Warning signs should conform with the general specifications for shape, color, and placement of warning signs. (secs. 1C–2, 3).

Typical miscellaneous warning signs are PLAYGROUND, BRIDLE PATH, TUNNEL, DRAW BRIDGE, UNEVEN TRACKS, ROUGH ROAD, HIGH WATER, LOOSE GRAVEL, LOW SHOULDER, RANGE CATTLE, (FACTORY) ENTRANCE, EXIT, and FALLING ROCK. The applications of such signs are sufficiently apparent as to require no detailed specifications.

Special warning signs for highway construction and maintenance sites are to be found in part V of this Manual.

D—GUIDE SIGNS

Section 1D–1 Application of Guide Signs

Guide signs are essential to guide the motorist along established routes, to inform him of intersecting routes, to direct him to cities, villages, or other important destinations, to identify nearby rivers and streams, parks, forests, and historical sites, and generally to give him such information as will help him along his way in the most simple, direct method possible.

Guide signs are here considered in three major groups:

1. Route markers and auxiliary markers (secs. 1D–9 to 26).
2. Destination and distance signs (secs. 1D–27 to 40).
3. Information signs (secs. 1D–41 to 46).

In the following sections standards for guide signs are prescribed both for the ordinary public highways and streets that constitute by far the greatest part of the nationwide network, and for modern expressways of high-type design. Standard signing for the Interstate System, cited herein, is detailed in the *Manual for Signing and Pavement Marking of the National System of Interstate and Defense Highways*,[8] published by the American Association of State Highway Officials. On any particular highway or class of highways, a consistent type of signs should be used.

Special types and applications of guide signs for use at construction and maintenance sites, and in civil defense traffic control, are treated in parts V and VI of this Manual.

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[8] Available from the American Association of State Highway Officials, 917 National Press Building, Washington 4, D.C.

Unlike most other types of signs, guide signs do not lose effectiveness by frequent use. When there is any doubt as to the advisability of any such sign, it should be erected. The amount of information on any one sign, or group of signs in close proximity to each other, however, should not be more than can be comprehended quickly by the drivers that are to be served. Since, furthermore, a guide sign must usually initiate a responsive decision, it must be so located as to permit any necessary maneuver to be made without confusion.

1D–2 Expressway Guide Signs

It is particularly true on expressways that guide signs offer problems of major importance. Expressway guide signs must be large enough and legible enough to be read from vehicles moving at high speed. At interchanges drivers must often depend altogether on signs in choosing the proper roadways, and because interchanges are relatively far apart, an error in turning may add miles to a driver's trip. On controlled-access roadways, also, it may be necessary to inform the traveler where he can reach certain service facilities that are not directly visible or accessible from the expressway. While expressway guide signs are in principle and in function the same as any other guide signs, the characteristic design of expressways requires special types of directional signs as herein specified.

The distinctive feature of expressway guide signs is that they incorporate all directional information needed—route numbers, destinations, and directions (or such of these as apply)—into single large signs, so placed in sequence as to give the traveler advance information concerning diverging roadways at an interchange and confirming information at the actual point of divergence. Since there are varying degrees to which expressway elements are incorporated into highway design, there is no sharp line to distinguish expressway signs or their application. Where, however, the following sections of this Manual refer specifically to expressway guide signs as a special category, it is assumed that such expressway sign standards will apply to the extent that full expressway design has been achieved. On the Interstate System, in many respects, even higher standards have been prescribed than for expressways generally.

1D–3 Design of Guide Signs

Guide signs convey various types of information, and a number of different colors are in use to make them distinguishable and legible (sec. 1A–11).

U.S. Route Markers and most State and local Route Markers, and auxiliary markers used therewith, are designed with black legend on a white background.

> *Interstate.*—Interstate Route Markers are of a distinctive red, white, and blue design, with auxiliary markers having white legend on a blue background. For business spurs and loops connecting with Interstate routes a green marker with white legend is provided for.

Destination and Distance signs are black on white, white on black, or white on green. Other informational signs, while generally of these same colors, are sometimes given special distinctive colors for easier recognition, as specified for individual signs in the following sections.

> *Interstate.*—On the Interstate System, all directional signs (other than Route Markers and their auxiliaries) are white on green, except that signs for rest areas and services are white on blue.

Except for certain Route Markers, which are of special shapes as specified hereafter, guide signs are rectangular, generally with the larger dimension horizontal.

All guide signs that have significance at night shall be reflectorized or illuminated. Any doubt should be resolved in favor of reflectorization or illumination.

1D–4 Size of Guide Signs

Guide signs must, above all, be legible to the drivers of vehicles approaching them. For signs with standardized designs, such as Route Markers, it is practicable to fix standard sizes. For most directional signs, however, the legend is so variable that there can be no rigidly standardized plate. The sign size must be fixed primarily in terms of the length of the message and the size of the lettering and spacing necessary for proper legibility.

The legend is not the only determinant of sign size. Under some circumstances, particularly for overhead signs, the available space must be considered. A sign mounted over a particular roadway lane to which it applies may have to be limited in length to the width of the lane, so that another sign can be placed over an adjacent lane. Overhead signs also must ordinarily be limited in their vertical dimensions, since roadway clearance must be maintained without putting any part of the legend above the height range of visibility for motor-vehicle drivers.

1D–5 Lettering on Guide Signs

The lettering for highway signs, standardized for many years, has been a rounded style of capital letters (sec. 1A–15). There has, however, been an increasing use of lower-case letters on expressway guide signs, particularly for names of destinations. There is some evidence that lower-case letters are more rapidly read than capitals, and that on a sign of a given size lower-case letters can provide a more legible message. Accordingly, lower-case letters are recognized as an equally acceptable alternative to capital letters for destination names on guide signs.

> *Interstate.*—Standards for the Interstate System require that all names of places and highways on guide signs shall be in lower-case letters with initial capitals. Other legend shall be in capital letters.

In all cases the heights herein specified for lower-case letters are the "loop heights" of those letters, i.e., the heights exclusive of ascending or descending stems. Initial capitals and numerals used with lower-case letters are 1⅓ times as high as the lower-case letters.

1D–6 Size of Lettering

For guide signs with varying legend the standards for legibility must be established in terms of letter size. The legibility distance must give the driver sufficient time to read the sign before he has passed it. Although under the best conditions a guide-sign message can be read and understood in a brief glance, a reasonable safety factor must be allowed for inattention, blocking of view by other vehicles, unfavorable weather, inferior eyesight, or other causes for delayed or slow reading. On the other hand, the usual repetition of directional information on successive signs on the approach to an expressway interchange often gives a driver more than one opportunity to obtain the information he needs.

Though the reading time for any given sign varies greatly with the speed of approach, standard lettering sizes should be consistent on any particular class of highways. Actually, the same conditions that make for lower speed—heavy traffic, frequent intersections or interchanges, unfavorable alinement, or extraneous distractions—usually create a need for greater legibility, hence the size standards set forth here are related to the type of highway rather than to variable speeds on any class of highway.

The minimum sizes specified should, of course, be exceeded where conditions indicate a need for greater legibility.

In rural districts on major routes (other than expressways), the principal legend on guide signs shall be in letters at least 6 inches in height, whether capitals or lower case. On less important rural roads and on urban streets the principal legend shall be in letters at least 4 inches high, whether capitals or lower

case. Sign panels shall be large enough to accommodate the required legend without crowding.

On expressways the principal legend on a guide sign mounted at the roadside on a through lane shall be in letters at least 10 inches high if capitals, or at least 8 inches if lower case. Much larger lettering is necessary for destination signs at and in advance of major interchanges. Miscellaneous informational signs, not essential for directional guidance, may be in smaller lettering.

Because most overhead signs are used in critical locations, they should generally have considerably larger lettering than is required for roadside signs.

> *Interstate.*—Standards for the Interstate System prescribe letter sizes in detail for each of the signs specified for use on the system.

1D–7 Amount of Legend on Guide Signs

Regardless of letter size, the legend on a guide sign must be so limited as to be readable during the few moments that a driver can turn his eyes from the road before him. Expressway guide signs, in particular, should be limited to three lines of principal legend on roadside signs, and two lines on overhead signs. This special limitation on overhead signs is desirable to keep all of the legend within the effective range of the driver's vision and adequately illuminated by the vehicle's headlights. It also recognizes the larger minimum letter size generally required for overhead signs.

For practical purposes, "principal legend" here includes only destinations—place names, route numbers, and highway and street names. Symbols, exit instructions, and cardinal directions may make up other "lines" of legend, within reasonable limits.

1D–8 Arrows on Guide Signs

Arrows are used on many guide signs to indicate the directions toward designated routes or destinations. Arrows are made to point horizontally or vertically, or at any desired angle to convey a clear comprehension of the direction to be taken. At right-angle intersections a horizontal arrow is appropriate. Since well designed expressway interchanges have no such sharp turns, a slanting arrow is to be preferred to a horizontal arrow in expressway directional signs. On a roadside sign a directional arrow for a straight-through movement should point vertically upward. For a turn the arrow should be pointed upward as will best suggest the plan of the intersection or interchange, and at an angle related to the sharpness of the turn.

On overhead signs directional arrows may be pointed upward or downward as will be most effective. Where it is desired to indicate a lane to be followed, it is the usual practice to point the arrow downward toward the center of that lane. Where a direction of travel is to be shown, an upward pointing arrow, vertical or slanting, is to be preferred.

> *Interstate.*—Standards for the Interstate System prescribe that all arrows shall point upward, except those on overhead destination signs directly above the through lanes to which they apply.

Arrows may be placed below the other sign legend, or to one side of it. On signs centered over the through lanes, a broad, short, downward pointing arrow below the legend is commonly used. At a turn-off an arrow at the far side of the sign may help to emphasize the directional significance of the sign. For adequate legibility it is recommended that the width across the barbs of the arrow be at least equal to the height of the largest letters on the sign, and for short downward-pointing arrows on overhead signs about 1¾ times the letter height.

1D–9 Route Markers and Auxiliary Markers

Route Markers shall be used to identify and mark numbered highway routes. Markers for each system of numbered highways shall be used only on routes of that respective system and the approaches thereto. Where two or more numbered routes follow the same section of highway, however, whether or not they are part of the same system, all of the applicable Route Markers, of whatever class, shall be displayed in combined mountings.

> *Interstate.*—For the Interstate System, special Route Markers are prescribed, to be used only on that system and approaches thereto.

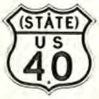
Route Markers are important to identify numbered highway routes, but to accomplish their purpose they are usually supplemented by various types of auxiliary markers to indicate junctions, turns, and route directions, as well as temporary, alternate, by-pass, and business routes, and detours. Except where used as Confirming or as Reassurance markers as hereinafter described (sec. 1D–10), or when incorporated into large directional signs on expressways, Route Markers are always mounted in conjunction with auxiliary signs to form Junction assemblies, Route Turn assemblies, Directional assemblies, or Trailblazer assemblies.

Route Markers, as such, have a less general application on expressways than on highways of older design, since route numbers and symbols are ordinarily incorporated into large interchange signs as provided for elsewhere in this Manual. Route

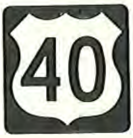
Markers in conjunction with auxiliary markers, used on other highways to show intersections and turns (including intersections with expressways), are not ordinarily used on expressways. Confirming Route Markers, however, should be used just beyond entrances and exits, and Reassurance markers at intervals as needed, along expressways.

1D–10 Design of Route Markers (M1–1, M1–2)

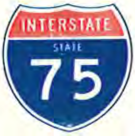
The U.S. Route Marker (M1–1) when used as a Confirming or Reassurance marker shall consist of a shield-shaped plate, of a standard size of 16½ inches by 16 inches, carrying the State name, the letters US and the route number in black legend on a white background. State Route Markers are designed by the individual State highway departments, but should be of approximately the same size as U.S. Route Markers.



M1–1
16½" x 16"



M1–2
24" x 24"



Interstate
Route Marker

When used in Junction assemblies, Route Turn assemblies, Directional assemblies, and Trailblazer assemblies, U.S. and State Route Markers shall consist of a square plate carrying only the white shield (or other distinctive shape) of the Route Marker with the route number in black. The area of the plate outside the Route Marker outline shall be black, without a border. The standard Assembly Route Marker plate shall be 24 inches square, with a small size 18 inches square for use on minor roads and secondary streets.

Enlarged Route Markers of any required size should be used where greater legibility is needed. The Assembly Route Marker may be used when an enlarged design is needed for a Confirming or Reassurance marker.

Interstate.—The Interstate Route Marker is a cut-out shield, in a red, white, and blue design. Confirming and Reassurance markers are of a 36-inch size. A 24-inch Route Marker is used on intersecting highways and approach roads to indicate an interchange with an Interstate route. An 18-inch size is used to make up a "Trailblazer" assembly (sec. ID–26). When used on a large Exit or Advance Exit sign (secs. 1D–36 to 39) to indicate an interchange with another Interstate route, the marker omits the State name, and is of a 36-inch

> size when destination names are in 12-inch letters (lower-case) or of a 48-inch size with 18-inch destination names. To direct traffic through or into the major business section of a city that is by-passed by an officially designated Interstate route, over an expressway that is not a part of the Interstate System, a special Business marker is provided for. This has white legend on a green background, and carries the number of the connecting Interstate route. A "loop" route leaves the Interstate route at an interchange on one side of the by-passed city and re-enters it at an interchange on the other side of the city. A "spur" takes business traffic into the by-passed city and back to the Interstate route over a single road and through the same interchange. The word INTERSTATE does not appear on the marker, as the route is not a part of the Interstate System. Except when used on an exit guide sign on the Interstate route, it is used only in a 24-inch size.

The American Association of State Highway Officials has authorized the use of a special Pan American Highway Route Marker on routes designated as parts of the Pan American Highway.

1D–11 Design of Route Marker Auxiliaries

For use with the 24-inch square Route Marker, auxiliary route markers carrying word legends (except the Junction marker) shall have a standard size of 21 inches by 9 inches. The Junction marker and those carrying arrow symbols shall have a standard size of 21 inches by 15 inches. With Route Markers of other sizes the auxiliary markers should be suitably reduced or enlarged in size.

If desired, the Route Marker and any auxiliaries used with it may be combined on a single panel of the same overall height as the assembly.

Route Marker auxiliaries shall be of the same color as the Route Markers they accompany, generally with black legend on a white background.

> *Interstate.*—For the Interstate System it is prescribed that Junction, Directional, and Cardinal Direction markers used with the Interstate Route Marker shall have white legend on a blue background. Directional Arrows used in Trailblazer assemblies, however, shall have a black symbol on a white background.

1D-12 Confirming and Reassurance Route Markers

Confirming Route Markers, without auxiliary Junction, Turn, or Directional markers, shall be erected just beyond intersections where the traveler might be in doubt as to his choice of route. In rural districts they should be placed not less than 25 feet nor more than 100 feet beyond the far roadway line of the intersected highway. In urban areas these distances should be 10 feet and 50 feet respectively. At expressway interchanges a Confirming Route Marker should be placed on the through roadway just beyond an exit gore, unless the through route is clearly designated on a sign at the gore. At an entrance ramp, where a driver has already proceeded too far to change his course, a Confirming Route Marker is not necessary, but there should be a Reassurance Route Marker placed within a reasonable distance beyond the interchange.

The application of Confirming Route Markers is illustrated in figures 1-6 to 1-8.

Reassurance Markers, also without auxiliary Junction, Turn, or Directional markers, shall be erected between intersections as required and just beyond the built-up area of any incorporated city or town.

Route Markers for either confirming or reassurance purposes should be spaced at such intervals as will keep the traveler sure of his route. In congested urban areas, the proper location of Route Markers is extremely important because it is very easy for the traveler to become confused and lose his route. Extreme care should be taken to erect the markers where they can be seen easily. If necessary, they should be located on the far side of every intersection along a numbered route, or so that at all times a Route Marker is plainly visible ahead.

In cases where a route designation incorporates a cardinal direction or constitutes an alternative route the Confirming or Reassurance Route Marker must be accompanied by the appropriate auxiliary markers. Only in such cases may Route Marker auxiliaries be used with any but the square Assembly Route Marker.

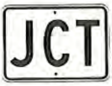
Where two or more routes follow the same road, Route Markers for all of the routes shall be erected on the same support. If different classes of numbered routes are shown, the Interstate, U.S. and State markers should be mounted in that order from the top of the grouping in a vertical arrangement or from the left in a horizontal arrangement. Subject to this order of precedence, Route Markers should be in numerical order from top to bottom or from left to right.

Confirming or Reassurance Route Markers shall be erected in accordance with the general standards for sign erection (secs. 1A–22, 23).

> *Interstate.*—On the Interstate System it is provided that a Confirmatory Route Marker shall be used 500 feet beyond the end of the acceleration lane at an entrance to an Interstate highway and at relatively long intervals along a route.

1D–13 Junction Marker (M2–1)

When large expressway-type directional signs are not used in advance of an intersection, the junction of two marked routes shall be indicated by a Junction assembly, consisting of a Junction marker mounted immediately above an Assembly Route Marker (M1–2). The Junction marker shall carry the abbreviated legend JCT. It shall have a standard size of 21 inches by 15 inches.



M2–1
21" x 15"

A Junction assembly shall be erected in advance of every intersection where a marked route is intersected or joined by another marked route (fig. 1–6). The Route Marker shall carry the number of the intersected or joined route. Where two or more routes are to be indicated, a separate Junction assembly shall be used for each route and all assemblies grouped in a single mounting, or a combination Junction sign (sec. 1D–14) shall be used. Two assemblies should preferably be mounted side by side rather than one above the other.

Where there are several assemblies, they should be arranged, so far as practicable, in the following manner:

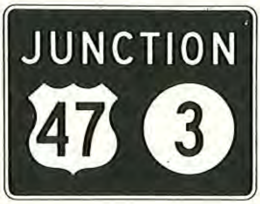
1. The assembly for a route intersecting from the left should be to the left of a horizontal grouping, or in the middle of a vertical grouping.
2. The assembly for a route intersecting from both left and right, or for a route proceeding only straight ahead out of the intersection, should be in the middle of a horizontal grouping, or at the top of a vertical grouping.
3. The assembly for a route intersecting from the right should be to the right of a horizontal grouping, or at the bottom of a vertical grouping.

The Junction assembly shall be mounted in accordance with the general specifications for highway signs (secs. 1A–22, 23), with the lowest unit in the assembly at the height prescribed for single signs.

In rural districts the Junction assembly shall be erected not less than 200 feet in advance of the intersection, on the right-hand side of the roadway and facing approaching traffic. The assembly thus serves as an intersection warning as well as a guide sign.

In residence and business districts the Junction assembly shall be erected approximately midway in the block preceding the intersection, but generally not more than 500 feet in advance of the intersection.

> *Interstate.*—For the Interstate System, it is prescribed that the Junction assembly on intersecting highways and approach roads shall be a standard 24-inch Interstate Route Marker with an 18-inch by 9-inch Junction sign having white legend on a blue background.



M2–2
48" x 36"

1D–14 Combination Junction Sign (M2–2)

As an alternative to the standard Junction assembly in residence or business districts, where more than one route is to be intersected or joined, a rectangular sign may be used carrying the word JUNCTION above the route numbers, each of which is identified as a U.S. or State number by an outline symbol as in the Assembly Route Marker (fig. 1–6). **The sign shall have a black background, with white lettering for the word JUNCTION and white Route Marker symbols carrying black numerals.** The size of the sign will depend on the number of routes involved, and the numerals should be large enough for clear legibility, comparable with those in the individual Assembly Route Markers. **The combination Junction sign shall not be used at a junction with an Interstate Route.**

The combination Junction sign shall be located and erected according to the specifications for Junction assemblies (sec. 1D–13).

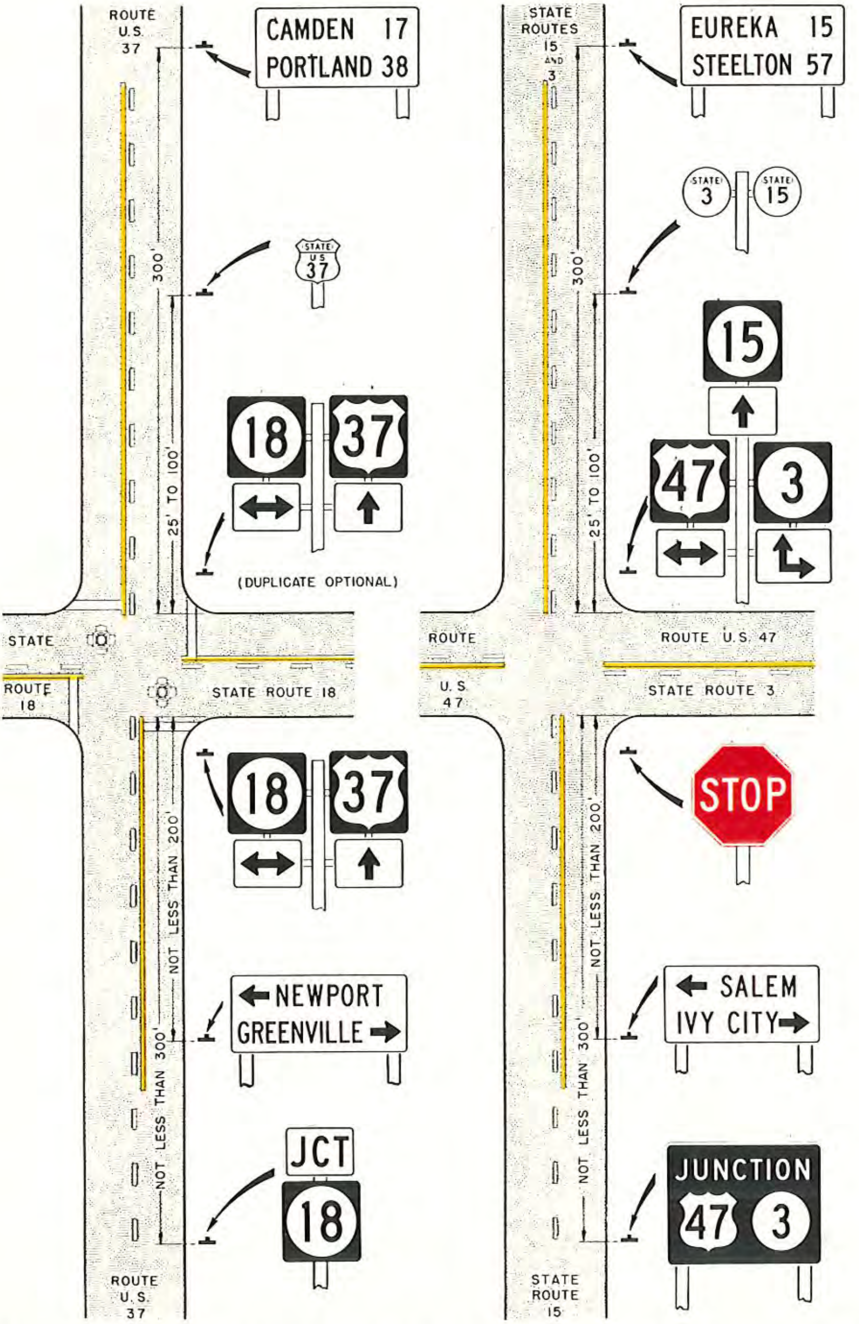
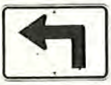

ROUTE U.S. 37
CAMDEN 17
PORTLAND 38
STATE US 37
300'
25' TO 100'
18
37
(DUPLICATE OPTIONAL)
STATE ROUTE 18
STATE ROUTE 18
18
37
NOT LESS THAN 200'
NEWPORT
GREENVILLE
NOT LESS THAN 300'
JCT
18
ROUTE U.S. 37
STATE ROUTES 15 AND 3
EUREKA 15
STEELTON 57
STATE 3
STATE 15
300'
15
47
3
25' TO 100'
ROUTE U.S. 47
ROUTE U.S. 47
STATE ROUTE 3
STOP
NOT LESS THAN 200'
SALEM
IVY CITY
NOT LESS THAN 300'
JUNCTION
47
3
STATE ROUTE 15

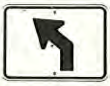
Figure 1–6.* *Typical route markings at intersections (for one direction of travel only).

1D–15 Advance Turn Arrow (M3–1, M3–2)

The Advance Turn Arrow shall be an auxiliary marker carrying a right or left arrow, the shaft of which is bent at a right angle (M3–1) or at a 45-degree angle (M3–2). It shall have a standard size of 21 inches by 15 inches.



M3–1
21" x 15"



M3–2
21" x 15"

The Advance Turn Arrow shall be placed directly under an Assembly Route Marker (M1–2) to form a Route Turn assembly. Where large expressway-type directional signs are not used, a Route Turn assembly shall be used on a numbered route in advance of an intersection to indicate a turn or change in direction of that route at the intersection.

If several overlapping routes turn at an intersection, each shall be marked, in advance of the intersection, with a separate Route Turn assembly, whether they turn in the same or in different directions. Where one or more routes turn while one or more proceed straight through, the routes that turn shall be marked with Route Turn assemblies, using the appropriate right or left advance turn arrows, while the straight-through routes are indicated by similar assemblies using the vertical directional arrow (M4–3, sec. 1D–16).

Route Turn assemblies may be omitted where the character of the roadway clearly indicates the course of the route or routes.

Route Turn assemblies for all routes should be grouped in a single mounting. Where there are routes turning in opposite directions, Route Turn assemblies for routes turning left should be mounted to the left of the group of assemblies, and those for right-turning routes to the right. If straight-through assemblies are used, the right- and left-turn assemblies should be to the right and left of them respectively. In a vertical arrangement the straight-through assemblies should be at the top, followed by left- and right-turn assemblies respectively.

The Route Turn assembly shall be erected in rural districts not less than 200 feet in advance of the turn, and in residence and business districts not more than 500 feet in advance, facing traffic approaching the intersection.

It is suggested that in congested districts the assemblies be duplicated, spaced at appropriate intervals. The assemblies should be located so that they will not turn traffic into an alley or secondary street in advance of the proper turn.

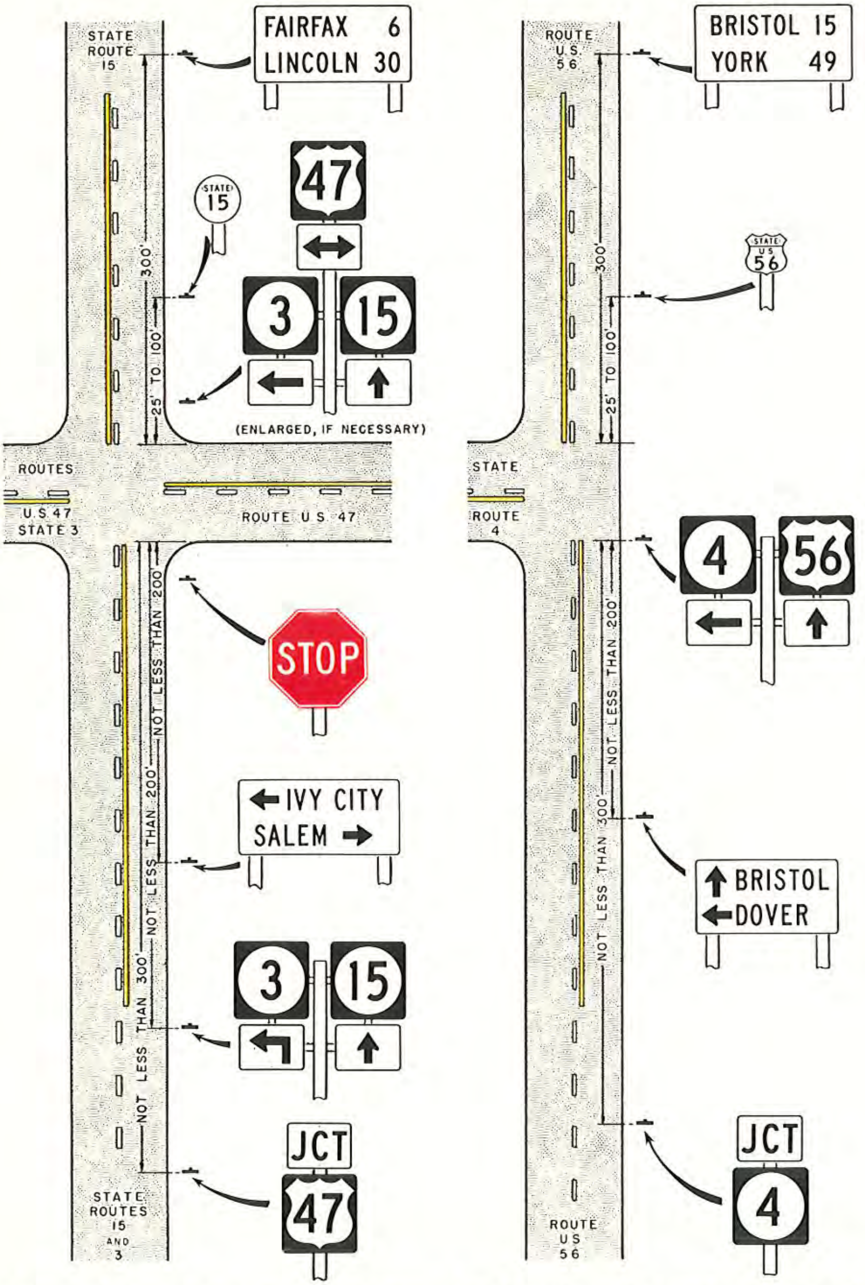

STATE ROUTE 15
FAIRFAX 6
LINCOLN 30
STATE 15
47
3
15
300'
25' TO 100'
(ENLARGED, IF NECESSARY)
ROUTES U.S. 47 STATE 3
ROUTE U.S. 47
STOP
NOT LESS THAN 200'
IVY CITY
SALEM
NOT LESS THAN 300'
3
15
JCT
47
STATE ROUTES 15 AND 3
ROUTE U.S. 56
BRISTOL 15
YORK 49
STATE U.S. 56
300'
25' TO 100'
STATE ROUTE 4
4
56
NOT LESS THAN 200'
BRISTOL
DOVER
NOT LESS THAN 300'
JCT
4
ROUTE U.S. 56

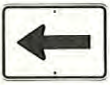
Figure 1–7. Typical route markings at intersections (for one direction of travel only).

The Route Turn assembly shall be mounted in accordance with the general specifications for highway signs (secs. 1A–22, 23), with the lowest unit in the assembly at the height prescribed for single signs.

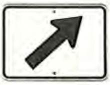
Figures 1–7 and 1–8 show typical applications of Route Turn assemblies.

1D–16 Directional Arrow (M4–1 to M4–7)

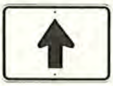
The Directional Arrow (M4–1 to 7) shall be an auxiliary marker carrying a single- or a double-headed arrow pointing in the general direction or directions in which a designated route may be followed. It shall have a standard size of 21 inches by 15 inches.



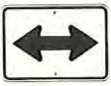
M4–1
21" x 15"



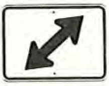
M4–2
21" x 15"



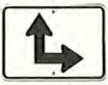
M4–3
21" x 15"



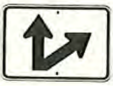
M4–4
21" x 15"



M4–5
21" x 15"



M4–6
21" x 15"



M4–7
21" x 15"

Interstate.—Along the Interstate System it is prescribed that the Directional Arrow used on intersecting highways and approach roads shall be 18 inches by 9 inches in size, used with a standard 24-inch Interstate Route Marker. It shall have a white symbol on blue background.

Where large expressway-type signs are not used, a Directional Arrow shall be mounted directly below a square Assembly Route Marker (M1–2) to form a Directional assembly, used at intersections to show (1) the direction of a route turn or (2) the direction or directions of an intersected route as described below:

1. A Directional assembly displaying the number of the turning route shall be used to confirm a turn or change in direction of a route at an intersection (indicated in advance by a Route Turn assembly, as prescribed in section 1D–15). A separate assembly shall be used for each turning route.

Only the single arrow (M4–1, M4–2) pointed in the direction of the turn, can be used in such an assembly (figs. 1–7, 8).

2. A Directional assembly, with the number of the intersected route and proper arrow, shall also be used to confirm a junction of two or more numbered routes (indicated in advance by a Junc-

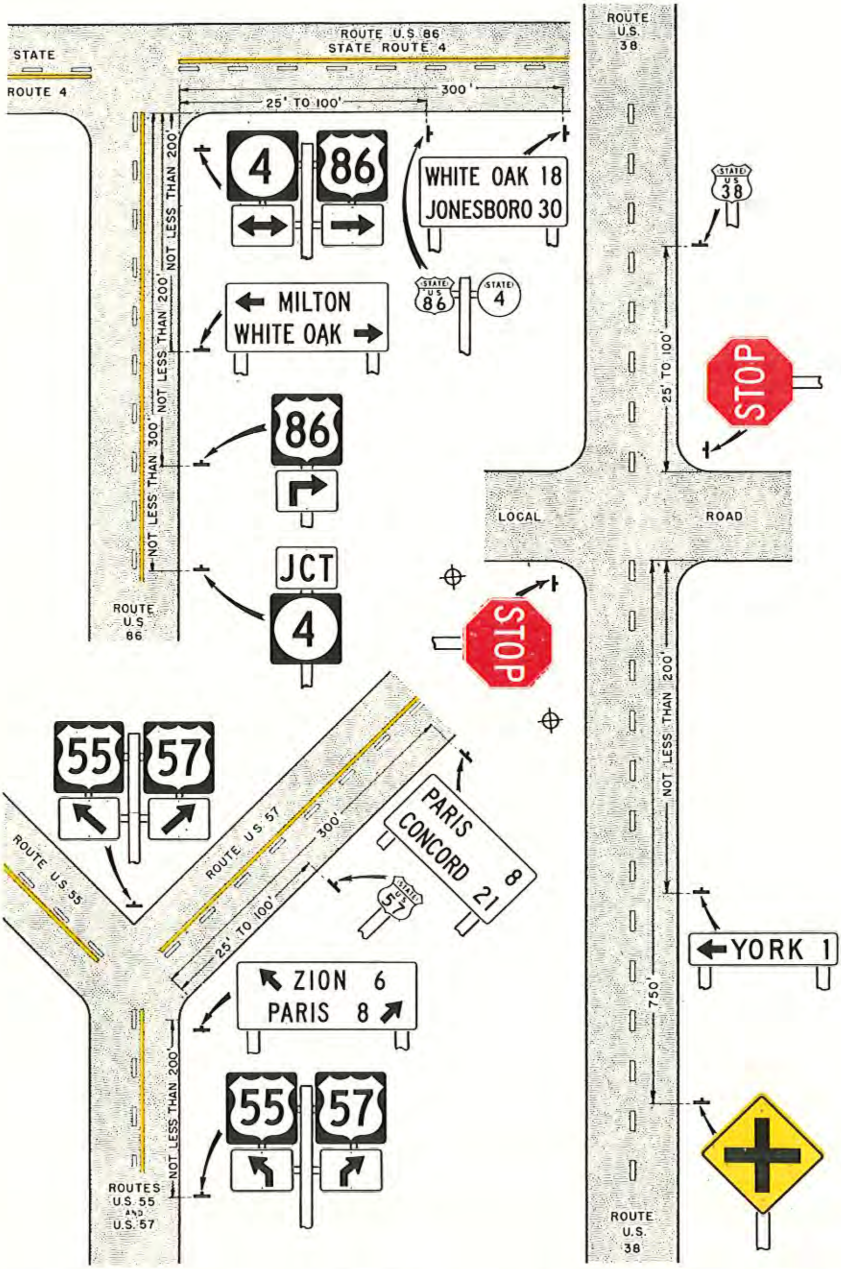

STATE
ROUTE 4
ROUTE U.S. 86
STATE ROUTE 4
300'
25' TO 100'
NOT LESS THAN 200'
NOT LESS THAN 200'
NOT LESS THAN 300'
4
86
WHITE OAK 18
JONESBORO 30
STATE
U.S.
86
STATE
4
MILTON
WHITE OAK
86
JCT
4
ROUTE
U.S.
86
ROUTE
U.S.
38
STATE
U.S.
38
25' TO 100'
STOP
LOCAL
ROAD
STOP
NOT LESS THAN 200'
YORK 1
750'
ROUTE
U.S.
38
55
57
ROUTE U.S. 55
ROUTE U.S. 57
300'
25' TO 100'
PARIS 8
CONCORD 21
STATE
U.S.
57
ZION 6
PARIS 8
NOT LESS THAN 200'
55
57
ROUTES
U.S. 55
AND
U.S. 57

Figure 1–8. Typical route markings at intersections (for one direction of travel only).

tion assembly as prescribed in section 1D–13), and to indicate the direction or directions of the intersected route (figs. 1–6, 7, and 8). When two or more numbered routes are intersected, a separate Directional assembly shall be used to mark each route.

When an intersected route begins at the intersection, a single-headed directional arrow shall be used (fig. 1–7). For a route crossed or entered at the intersection a double arrow shall be used, pointing at appropriate angles to left or right or ahead (figs. 1–6, 7, and 8). Optionally, a separate Directional assembly may be used for each direction of an intersected route, with an appropriate Cardinal Direction marker (sec. 1D–25).

Where one or more routes turn or are intersected and one or more routes continue straight through, the straight-through route shall be marked by a Directional assembly using the vertical arrow (M4–3). A Directional assembly with vertical arrow, however, should not be used at any intersection alone, in the absence of other assemblies indicating right or left turns. The Confirming Marker just beyond the intersection (sec. 1D–12) provides adequate marking for a route passing straight through, where there are no turning or intersected routes.

All Directional assemblies, whether for route turns or for intersected routes, facing traffic entering an intersection from a single direction shall be on a single mounting. Where more than one route turns or is intersected, the assemblies should be arranged as follows:

1. In a horizontal grouping the single arrows pointing to left or right should be to the extreme left or right of the arrangement, respectively. A vertical arrow should be at or near the center of the group, with the double arrows on either side in such a manner as will best emphasize their directional indications.
2. In a vertical grouping the vertical arrow should be at the top, followed by other single arrows pointing to left and right (in that order) and then by the straight and the bent double arrows.

In some instances it will be advantageous to give emphasis to a particular Directional assembly by giving it a more conspicious position in a grouping than it would have in one of the above arrangements.

1D–17 Location of Directional Assemblies

A Directional assembly or group of Directional assemblies shall normally be located on the near right-hand corner of the intersection. At major intersections it is often desirable to install additional assemblies on the far right-hand or left-hand corner to confirm the near-side assemblies.

It is more important that guide signs be readable at the right time and place than that they be located with absolute uniformity. When the near-corner position is not practical for directional assemblies, the far right-hand corner is the preferred alternative, with oversize signs if necessary for legibility. Similarly, if it is found advantageous to place a Directional assembly in advance of the intersection, an additional assembly should be mounted on the far right-hand corner. The standard near-corner location, however, places the Directional assembly where it can be read at close range, without interference from cross traffic, and this should be held to in the absence of compelling reasons to the contrary.

The Directional assembly shall be mounted in accordance with the general specifications for highway signs (secs. 1A–22, 23), with the lowest unit in the assembly at the height prescribed for single signs. Care should be taken that groups of Directional assemblies in a single mounting will not block the view in any direction at an intersection.

At complex intersections or interchanges, with connecting ramps or one-way roadways, the effective location of directional markings is often exceedingly difficult to achieve. It may be best under some circumstances to separate the Directional assemblies so that those indicating a turn will be on the near side of the turn and those for straight-ahead traffic on the far side. However, no rules are here prescribed for directional signs at such intersections, as each must be studied independently and the best route marking be worked out by observation and experiment. The use of expressway-type signing (secs. 1D–33 to 39) may be warranted. It must be remembered that at complex interchanges the motorist cannot depend on his sense of direction to tell him whether to turn right or left, and that he is wholly dependent on the signs he reads. It is absolutely necessary, therefore, that the directional guidance be clear and unmistakable.

1D–18 Markers for Alternative Routes (M5–1 to M5–7)

It is often necessary to relocate a numbered route temporarily, or to show an alternative routing for a special purpose. **An auxiliary plate carrying the legend TEMPORARY, ALTERNATE (or ALT), BY-PASS (or RELIEF), BUSINESS, or DETOUR shall be mounted immediately above a Route Marker to designate such a route. When used with an Assembly Route Marker it shall**

have a standard size of 21 inches by 9 inches (sec. 1D–11). The combination shall be used as a Confirming or Reassurance Route Marker or as part of a Junction, Turn, or Directional assembly, and shall be located and erected in the same manner.

The designation of Alternate, By-Pass, or Business U.S. routes is in accordance with the established policy of the American Association of State Highway Officials.[9] No route may be so designated and marked without the approval of the Executive Committee of the Association.

1D–19 Temporary Marker (M5–1)

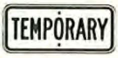
The TEMPORARY marker shall be used as specified in section 1D–18 to indicate either:

1. A route temporarily designated but not intended as a permanent part of a regularly numbered route, or

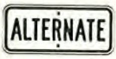
2. A temporary detour from an established route, due to emergency or major reconstruction.

Where it is planned to relocate a route at a later date, use of the "temporary" designation will often help to avoid future misunderstanding and ill feeling. On the other hand, the use of "temporary" instead of "detour" avoids the suggestion of poor road that is associated in the public mind with the latter term. The temporary route may be another U.S. or State numbered route, a county or township road, or a city street.

Temporary markers shall be promptly removed when the temporary route is abandoned.



M5–1
21" x 9"



M5–2
21" x 9"

1D–20 Alternate Marker (M5–2)

The ALTERNATE (or ALT) marker shall be used as specified in section 1D–18 to indicate an officially designated alternate routing of a numbered route between two points on that route.

1D–21 By-Pass Marker (M5–3)

The BY-PASS marker (M5–3) shall be used as specified in section 1D–18 to designate a route that branches from the regular

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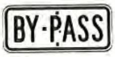
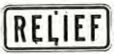
[9] *Purpose and Policy in the Establishment and Development of United States Numbered Highways,* 1959, American Association of State Highway Officials, 917 National Press Building, Washington 4, D.C.

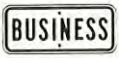
numbered route through a city, by-passes a part of the city or congested area, and rejoins the regular numbered route beyond the city. Where the alternative route is intended to divert part of the traffic from a heavily traveled numbered route, it may be designated by a RELIEF route marker (M5–4).



M5–3
21" x 9"



M5–4
21" x 9"



M5–5
21" x 9"

1D–22 Business Route Marker (M5–5)

The BUSINESS route marker shall be used as specified in section 1D–18 to designate an auxiliary route that branches from a regular numbered route through a city to carry traffic through the business portion of the city.

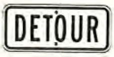
> *Interstate.*—The marking of certain business spur or loop routes connecting with the Interstate System is by means of special Route Markers (sec. 1D–10).

1D–23 Detour Marker (M5–6)

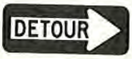
The DETOUR marker shall be used as specified in section 1D–18 to indicate an emergency routing of traffic due to a temporary closing or blocking of the regularly marked route. Conditions calling for a detour include road reconstruction or major maintenance work, a closed bridge, high water, or similar circumstance that makes the regular route impassable or inconvenient for travel. The Detour assembly should be located and erected in general accordance with the specifications for regular Route Markers. However, since detours frequently necessitate the use of unimproved or poorly defined roads, there is greater likelihood that motorists following the route may become confused. Extreme care should be exercised to see that Detour assemblies are located and erected as conspicuously as possible and at short intervals as needed.

The use of the Temporary marker (M5–1) in place of the Detour marker is optional. "Temporary" does not carry the suggestion of inferior roads often associated with the term "detour."

A supply of Detour or Temporary markers should be kept on hand in all highway districts for prompt use as needed. When the regular route is reopened, all Detour or Temporary markers should be removed immediately.



M5-6
21" x 9"



M5-7
24" x 9"

1D-24 Detour Arrow Sign (M5-7)

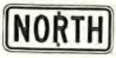
An alternative method for marking detours, particularly in emergencies, is the use of the Detour Arrow sign. This is a rectangular sign of a standard size of 24 inches by 9 inches having a white arrow on a black background and the word DETOUR centered on the arrow. It should be made in rights and lefts so it can be mounted to point in either direction.

This sign, in emergencies and where, over relatively short distances, it is not necessary to show route numbers, may be posted in the most expedient manner, and as frequently as necessary to guide traffic along the detour and back to its desired route.

In a greatly enlarged size, this sign is prescribed for use on barricades in the roadway where a road is closed for construction or major maintenance operations (sec. 5B-39).

1D-25 Cardinal Direction Marker (M6-1)

The Cardinal Direction marker, carrying the word EAST, WEST, NORTH, or SOUTH, may be mounted directly above a Route Marker to indicate the general direction of the route. It may be used where motorists in transferring from one route to another might be confused as to the direction in which the intersected route would take them. It may also be used elsewhere for reassurance.



M6-1
21" x 9"

The Cardinal Direction marker for use with an Assembly Route Marker shall have a standard size of 21 inches by 9 inches (sec. 1D-11).

Interstate.—On the Interstate System and approaches thereto, the Cardinal Direction marker, if used with an Interstate Route Marker, shall be blue, with white legend. It shall have a size of 18 inches by 9 inches if used with a 24-inch Route Marker, and 30 inches by 15 inches with a 36-inch Route Marker.

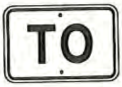
The Cardinal Direction marker only supplements a Route Marker in any application and does not affect its location or manner of erection.

1D–26 Trailblazers

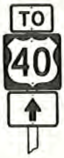
Some traffic authorities have found it desirable to provide directional guidance to expressways, bridges, or similar special highway facilities from other highways in the vicinity. This is accomplished by means of "Trailblazers" erected at strategic locations, usually along major urban thoroughfares, to indicate the direction to the nearest or most convenient point of access. Such Trailblazers should be an assembly consisting of the following:

1. An 18-inch by 12-inch plate having the word TO in 6-inch black letters on a white background (M7–1). This plate is desirable to make it clear that the traveler is not already on the facility referred to.
2. Just below it, if needed, a Cardinal Direction marker (sec. 1D–25).
3. A Route Marker or other symbol, not exceeding 24 inches in its largest dimension.
4. A single Directional Arrow of a size proportionate to the Route Marker or symbol (sec. 1D–16).

If desired these several components may be combined on a single panel.



M7–1
18" x 12"



Trailblazer assembly

The Cardinal Direction marker is often needed where different interchanges will be used for access to the indicated facility, depending on the direction in which it is desired to travel after reaching it.

Interstate.—For the Interstate System it is prescribed that the Trailblazer assembly shall consist of an 18-inch Interstate Route Marker, a white panel with the word TO in 6-inch capital letters, a Cardinal Direction marker if needed, and a standard Directional Arrow in black on a white plate, arranged in the vertical order described above, separately or incorporated in a single panel.

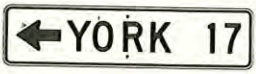
1D–27 Destination and Distance Signs

In addition to guidance by route numbers it is necessary to supply to the traveler information concerning the destinations that can be reached by way of numbered or unnumbered routes. This is done by means of Destination and Distance signs.

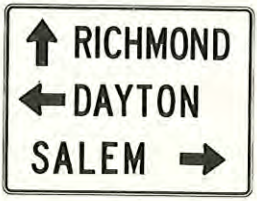
These signs shall have black legend on a white background, or white legend on a black or green background (sec. 1D–3). A dark background is preferable for overhead signs. The white background or white letters shall be reflectorized while reflectorization of the green background is optional. On any particular highway, color and reflectorization should be consistently uniform.

A further special characteristic of these signs is that destination names may be in lower-case letters with, of course, initial capitals.

For expressways, a more or less standardized arrangement of directional signs has been developed, as described in sections 1D–34 to 39.



D1
Variable size



D1
Variable size

1D–28 Destination Sign (D1)

Except on expressways, for which special interchange signing is prescribed (secs. 1D–33 to 39), the Destination sign shall be a horizontal rectangle carrying the name of a city, village, or other objective, and a directional arrow. The mileage to the place named may also be shown. If several destinations are to be shown at a single point, the several names may be placed on a single panel with an arrow (and the mileage, if desired) for each name. If more than one destination lies in the same direction, a single arrow may be used for such a group of destinations, but in any case adequate separation should be made between any destination or group of destinations in one direction and those in other directions, by suitable design of the arrows, spacing of the lines of legend, heavy lines entirely across the panel, or separate panels.

An arrow pointing to the right shall be at the extreme right of the sign, and an arrow pointing left or vertically shall be at the extreme left, unless there is only one direction to turn, in which case the arrow may be at the bottom of the sign. The mileage figures, if used, shall follow after the destination name. Horizontal or sloping arrows should be of sufficient length to be clearly distinguishable from the vertical arrow. As a general rule, the directional arrows should be horizontal or vertical, but at an irregular intersection a sloping arrow will sometimes convey a clearer indication of the direction to be followed.

The size of the lettering for U.S. and State numbered routes and other major routes shall be no less than that specified in section 1D–6. In some instances the names of major destinations may be in larger letters than those of minor destinations on the same sign. If, however, several individual name panels are assembled into a group, all panels in the assembly should be of the same length.

Destination signs are generally warranted:

1. At the intersections of U.S. or State numbered routes with Interstate, U.S. or State numbered routes.
2. At points where they serve to direct traffic from U.S. or State numbered routes to the business section of towns, or to other destinations reached by unnumbered routes.

Preferably not more than two or three names should be used in combination on one or more signs. As a general rule, the next important city or point of interest lying straight ahead should be at the top of the sign or assembly, and below it the next important destinations to the left and to the right, in that order. In the case of overlapping routes, there should be shown only one destination in each direction on each route. If there is more than one destination shown in any direction, the name of the nearest city or town should appear above that of any farther away.

Placing the vertical arrow at the top is not only consistent with the recommended arrangement for Route Marker assemblies, but also has the advantage that the arrow definitely points away from the other names shown. The sequence of left and right arrows also is like that specified for Route Marker assemblies, and gives priority position to the left turn, for which the driver must properly position himself in the center lane.

The choice of destination names must be somewhat flexible. The destination shown for each direction should ordinarily be the next county seat or the next principal city, rather than a more distant destination.

1D–29 Location of Destination Signs

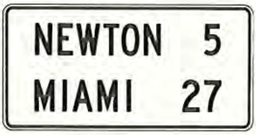
In rural districts Destination signs should generally be located not less than 200 feet nor more than 300 feet in advance of the intersection, and following any Junction or Route Turn assemblies that may be required. In urban areas somewhat shorter distances may be justified. The motorist must have an opportunity to make up his mind as to the direction he wishes to go before he reaches the intersection, so he can get into the proper lane for turning if necessary. Supplementary or confirmatory Destination signs may be erected on the far right-hand corner of the intersection, or, at a T or Y intersection, on the far side of the intersection directly ahead of approaching traffic.

Height and lateral placement of Destination signs shall be in accordance with the general standards for sign erection (secs. 1A–22, 23).

Figures 1–6 to 1–8 show the use of Destination signs at rural intersections.

1D–30 Distance Sign (D2)

The Distance sign shall be a horizontal rectangle of a size appropriate to the required legend, carrying the names of not more than three, and ordinarily of only two incorporated cities, villages, or towns, and the mileages (generally to the nearest mile) to the centers of those places.



D2
Variable size

As a general rule the top name should be that of the next place on the route having a post office, railroad station, or other significant geographical identity. The lowermost name should be that of the major destination of the route, or the city in which the greater portion of the through traffic is interested. If a third name is included it should be that of the next county seat, important city, or important route junction.

The lowermost name should remain the same on successive signs throughout the length of the route until that destination is reached. There are circumstances, however, under which more than one distant point may properly be designated, as, for example, where the route divides at some distance ahead to serve two destinations of similar importance. If these two destinations cannot appear on the same sign, some alternation of the two names may be justified. On a route continuing into another State, the name of a city in the adjacent State may be shown.

On urban expressways where interchanges are closely spaced, the Distance sign may show, instead of place names, the route or destination designations for the next two or three exits, with mileages thereto, normally in fractions of a mile.

Since this sign is for information only, and does not call for any direct response, it is permissible to use 8-inch capitals or 6-inch lower-case letters in place of the minimum of 10-inch capitals or 8-inch lower-case letters prescribed for expressway guide signs in section 1D–6.

1D–31 Location of Distance Signs

Distance signs shall be erected on important routes leaving municipalities, and just beyond intersections of numbered routes in rural districts, or at intervals of approximately 10 miles along the route. They should not ordinarily be used on any but major routes.

Distance signs shall be placed on the right-hand side of the road, facing traffic leaving the municipality, approximately 500 feet outside of the municipal limits, or at the edge of the built-up district if it extends beyond the corporation limits. Where overlapping routes separate a short distance from the corporation limits, the Distance sign should be omitted at the corporation limits and should be erected 300 feet beyond the junction of the two routes.

Where, just outside of an incorporated municipality, two routes are concurrent and continue concurrent to the next incorporated municipality, the top name on the sign placed at such a point should be that of the place where the routes separate; the lower name should be that of the city in which the greater part of the through traffic is interested.

On expressways the Distance sign shall be erected at the roadside within half a mile beyond the last entering roadway at each interchange, and at random intervals as desired for reassurance. In urban areas where interchanges are closely spaced the sign need not be placed beyond every interchange.

> *Interstate.*—Standards for the Interstate System prescribe the display of a Distance (or Mileage) sign 2,500 feet beyond the end of an interchange acceleration lane, where space between interchanges permits. The sign is to carry not more than two destinations, the next community or the next intersected highway or interchange on the route, followed by the next point of general in-

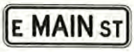
terest, together with the corresponding mileage information. The legend shall be in 10-inch lower-case letters, with initial capitals and numerals 13.3 inches high.

Distance signs shall be erected in accordance with the general standards for sign erection (secs. 1A–22, 23).

Figures 1–6 to 1–8 show the use of Distance signs at rural intersections.

1D–32 Street Name Sign (D3)

Street Name signs should be erected and maintained by the municipality, and should be placed at all street intersections regardless of other route marking that may be present. Colors should be one of the combinations prescribed for Destination and Distance signs (sec. 1D–27), or other combination giving good contrast and legibility.



D3
Variable size

The street name shall appear in capital lettering at least 3 inches high, and, on more important streets, not less than 4 inches high. Supplementary lettering to indicate the type of street (e.g., Street, Avenue, Road, etc.) or section of city (e.g., N.W.) may be in smaller lettering, at least 2 inches high. Conventional abbreviations are acceptable except for the street name itself.

The Street Name sign should preferably be reflectorized or illuminated.

In business districts Street Name signs shall be placed at least on diagonally opposite corners so that they will be on the far right-hand side of the intersection for traffic on the more important street. Signs naming both streets should be erected at each location. They should be mounted with their faces parallel to the streets they name, as close to the corner as practicable with the nearest part of each sign not less than 1 foot, and preferably 2 feet, back from both curb lines. They should be not less than 7 feet above the top of the curb, either at the same height or with one immediately above the other in a crossed position.

In residence districts Street Name signs should be mounted as in business districts, but a single location at each intersection will ordinarily suffice on all but the more important thoroughfares.

Care should be taken in all cases to insure that the signs are placed where they can easily be seen by motorists and pedestrians.

ID–33 Expressway Directional Signs

The special design of expressways, the high speed and volume of the traffic using them, and the relatively large proportion of non-local traffic in need of guidance, all call for directional signs of special design and application. The following sections, accordingly, deal specifically with expressway directional signs in relation to interchanges as they constitute a more or less distinct category of signs. These signs, in proper sequence, combine the functions of separate Route Markers and Destination signs, as above specified for other highways, to give all necessary directional guidance through interchanges that are often of complex design.

1D–34 Interchange Sign Requirements

An interchange on an expressway usually connects with a numbered or named highway or street. In most cases, also, that intersected highway will lead to some destination or destinations of interest, in one or both directions. As a general rule, therefore, both route numbers and destinations must be shown on interchange signs. In urban areas a street name may be all that can be shown, without reference to any particular destination. The designation of interchanges by name may be advantageous under some circumstances, but generally an interchange can be identified by the name or number of the intersected highway or the chief destination thereon. A special interchange designation only adds to the legend that must appear on the interchange signs. Numbering of interchanges is subject to the further disadvantage that it assumes definite termini for an expressway and a fixed number of interchanges

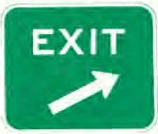
On expressway guide signs the emphasis should always be placed on the information that will be most helpful to the stranger unfamiliar with the route.

1D–35 Expressway Interchange Signs

Where interchanges are relatively far apart it is desirable and necessary to give long-range advance notice of each exit and the routes or destinations served by it. For each major interchange there should be a minimum of three guide signs (or assemblies of guide signs) and a maximum of five, not including any duplicate signs placed on the left side of the roadway to supplement the regular signs. The following sections describe (in reverse order, counting outward from the interchange toward the approach traffic) the signs that should appear at the interchange and in advance of it.

1D–36 Gore Signs (E1–1 to 4)

At the point of exit at an interchange, in addition to any advance signs, it is necessary to have a final guide sign to mark the diverging roadway. This sign should be located in the gore between the diverging roadways, as near to the point of divergence as necessary clearances will permit, or as an overhead sign above the roadway or roadways at the actual point of divergence.

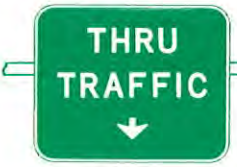


E1–1
Variable size

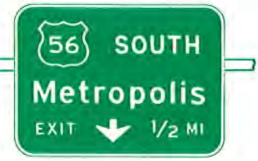
When adequate advance directional signs are in place, and there is only a single exit at an interchange (for a given direction of approach traffic), it may be sufficient to mark the diverging ramp by a Gore sign carrying the single word EXIT and an arrow (E1–1). Where it is desirable to provide confirming guidance at the gore, and, in any case, where there are two exit ramps at the interchange, the Gore sign should show, for diverging traffic and for through traffic, not more than two destinations served by each of the roadways or lanes, with applicable route numbers or names, and directional arrows. Under some circumstances the route number or name may be the only significant information that can be shown, particularly where interchanges are at street intersections serving local destinations within a metropolitan area. In urban areas, too, it may be unnecessary to repeat at every interchange the destination of the expressway itself.

> *Interstate.*—Standards for the Interstate System prescribe that the Gore sign at an interchange having a single exit shall carry only the word EXIT in 12-inch capital letters, with an upward-pointing slanting arrow. At minor interchanges 8-inch letters are permissible. However, where the distance between interchanges is short and it is necessary to place advance signing in the immediate vicinity of the previous interchange, an overhead sign installation may be used to carry not only a Gore sign with exit information and arrow but also the exit guide sign for the next interchange.

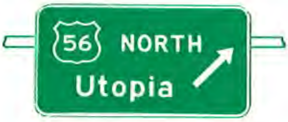
Where there are two exit ramps at an interchange, it is necessary to provide directional information at both gores, in such a manner as to distinguish the directions and destinations served by the two exits. In this case there should be, at the first gore, one sign showing the route and destination served by the first exit ramp, with a directional arrow (typically, E1–2), together with another sign showing the corresponding information for the second exit, with an arrow pointing toward the through lanes and, if desired, an indication of the distance to the second exit (typically, as an overhead sign, E1–3). The two signs, if at the roadside or within the gore, may be combined on a single plate, but if overhead, they should be mounted side by side over the roadways to which they apply.



E1–4
Variable size



E1–3
Variable size



E1–2
Variable size

At the second gore there should be a sign giving directions for the second exit, similar to that for the exit ramp at the first gore.

Where there are two exits it is necessary, as a rule, to accompany the route number or name of the intersected route with a cardinal direction indication (NORTH or SOUTH, for example) showing the general direction in which traffic will proceed on the designated route by way of the ramp so marked.

If two directions are shown, one above the other, on a single sign, a heavy horizontal line should be used to separate the destinations and their arrows. Two separate signs, one above the other, may accomplish the same purpose even better.

As a general rule only one destination in each direction should be designated. A secondary destination may be shown in letters somewhat smaller than the minimum size prescribed for the principal message.

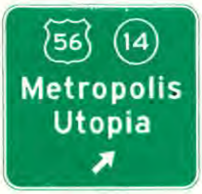
> *Interstate.*—Standards for the Interstate System prescribe that the Gore destination sign at the first exit of an interchange with two exit ramps shall be overhead. The sign over the exit roadway carries the route number or name, the cardinal direction, and the one destination, with an upward-sloping arrow pointing in the direction of the exit traffic movement (E1–2). Over the through lane on the side from which the second exit ramp takes off there is a sign carrying similar directional informa-

tion for the second exit, but with a vertically downward-pointing arrow and the distance to the next exit (E1–3). Over the remaining through lane or lanes a sign reading THRU TRAFFIC with a vertically downward-pointing arrow is used (E1–4). Where the distance between interchanges is short, however, this last sign may be replaced by an advance exit guide sign (sec. 1D–38) for the next interchange. At the second exit a ground or overhead sign is placed in the gore, similar to that over the exit ramp at the first gore. The THRU TRAFFIC sign is in 18-inch capital letters. The other Gore signs carry route numbers in 12-inch numerals and destinations or street names in 12-inch lowercase letters with 16-inch initial capitals.

The above standard for the Interstate System is recommended for use on high-type expressways generally, to the extent that such expressways are built to Interstate standards.

1D–37 Exit Direction Sign (E2)

At or in advance of the gore, generally at the beginning of the deceleration lane at the exit, a directional sign should be placed to indicate the proper lane to be taken by drivers who intend to leave the expressway at that exit (typically, E2).



E2
Variable size

This sign should show (1) the number or name of the route with which the ramp connects, (2) the cardinal direction in which that route leads, if the ramp gives access to only one of two possible directions for the intersected route, (3) the name or names of not more than two principal destinations on that route, and (4) a directional arrow, or a word message such as KEEP RIGHT (or LEFT) or RIGHT (or LEFT) LANE, in lettering smaller than that of the principal legend. If there are exits on both sides of the roadway, the sign should so indicate, but it should not normally give directions for the through lanes of the expressway. The word message in place of the arrow is to be preferred where the actual course of the exit cannot be seen clearly by the driver as he approaches, or where the sign must be placed in advance of a short deceleration lane in order not to be too close to the Gore signs, in which case the sign should be located one-fourth to one-half mile in advance of the gore. With an arrow the sign should always be located so that the symbol will be readily associated with the departure point and alinement of the exit ramp.

Where the exit ramp serves both directions on the intersected highway, two destinations will ordinarily be shown. On the other hand, as in metropolitan areas, there may be interchanges where no specific destinations can be indicated.

Where there is an adequate overhead sign at the gore giving the needed directional information, and where the distance between interchanges is short or there are at least two advance exit guide signs, the Exit Direction sign may be omitted.

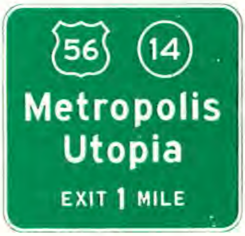
Where, as at a cloverleaf interchange, there are two exit roadways both diverging to the right, the Exit Direction sign should show directional information only for the first exit. The Gore sign at the first exit will normally serve as the Exit Direction sign for the second exit, but if there is sufficient distance for the installation of a second Exit Direction sign between the first and the second exits it should be used.

> *Interstate.*—Standards for the Interstate System prescribe the use of the Exit Direction sign, with arrow or legend RIGHT (or LEFT) LANE, at the beginning of or in advance of the deceleration lane, as described above. The route number is in 12-inch numerals, the destination name or names in 12-inch lower-case letters with 16-inch capitals, and the words RIGHT LANE in 12-inch capitals. When at least two advance exit guide signs are used and the Gore sign is an overhead installation, the Exit Direction sign should usually be omitted.

1D–38 1-Mile Advance Sign (E3–1)

At approximately 1 mile from an interchange an advance sign shall be placed, showing the principal destination or destinations served by the interchange, and the connecting route number or street name, or such of this information as is significant, with the legend EXIT 1 MILE, or the approximate distance if less than one mile (typically, E3–1). The word EXIT is necessary, as the named destinations lie at some distance from the exit.

Two destinations (particularly if lying in different directions) must often be shown, but not more than two should be listed, as a rule. If, as at a cloverleaf interchange, there are two separate exits for different directions on the intersected highway, this sign should show the principal destination for each of the exits, and the sign should read EXITS 1 MILE.



E3–1
Variable size

This sign shall be erected on the right-hand side of the roadway, with a duplicate installation on the left, if warranted for better visibility. Under special circumstances an overhead sign may be justified (sec. 1A–21).

The 1-Mile Advance sign is perhaps the most important of the interchange guide signs. It should be as large as necessary to command notice and provide ample legibility.

> *Interstate.*—Standards for the Interstate System prescribe the use of this sign in advance of every interchange, normally at the distance of 1 mile. The "desirable" and "minimum" sizes of lettering are specified in detail for major, intermediate, and minor interchanges respectively, ranging from 18-inch capitals and lowercase letters (the latter with 24-inch initial capitals) for the more important legend at major interchanges to 10-inch and 8-inch letters for parts of the legend at minor interchanges. At minor interchanges the sign is placed one-quarter to one-half mile from the interchange, and carries the legend RIGHT LANE instead of EXIT 1 MILE.

For high-type expressways it is suggested, as a minimum standard for the 1-Mile Advance sign, that the route numbers and cardinal directions be 12 inches high, the place names be in 12-inch lower-case letters with 16-inch initial capitals, and the words EXIT and MILE be in 8-inch capitals with a 12-inch numeral. These letter sizes are a little below those specified for intermediate interchanges on the Interstate System. In urban areas, where interchanges are closely spaced or where speeds are relatively low, and where visibility of signs is not interfered with by extraneous lights or commercial signs, a smaller lettering may be adequate.

When the distance between interchanges is less than 1 mile, the Gore sign at the preceding interchange (provided that it shows the necessary route, destination, and directional information) may be construed to be the 1-Mile Advance sign for the next interchange, or the 1-Mile Advance sign may be placed at the greatest practicable distance, less than 1 mile, with an appropriate change of indicated distance.

1D–39 2-Mile Advance Sign (E3–2)

The signs described in the three preceding sections constitute the minimum acceptable signing for an expressway interchange. On high-speed expressways with a wide spacing of interchanges an additional advance sign is desirable at a distance of approximately 2 miles. It should be generally identical with the 1-mile sign except for the distance indicated, and erected in the same manner.

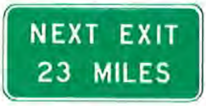
Where the distance between interchanges is less than 2 miles, the sign with an appropriate change of indicated distance may be placed at 1½ miles in advance of the interchange.

> *Interstate.*—Standards for the Interstate System prescribe the use of the 2-Mile Advance sign at all "major" interchanges.

Other advance destination information signs are provided for in sec. 1D–44.

1D–40 Next Exit Sign (E4)

Where exits are several miles apart and failure to make a desired turn at an interchange would require a driver to go a number of miles out of his way, it may be desirable to place a sign in advance of each interchange showing the distance from that interchange to the next one. Such a sign standing alone would be highly misleading, since it actually does not refer to the immediate "next exit." An appropriate location for it is below the 1-Mile Advance sign or, less desirably, as a subordinate legend on that sign. The wording should be NEXT EXIT (10) MILES in letters of a minimum height of 8 inches (E4). If



E4
Variable size

made a part of the 1-Mile sign, the legend should be separated from that above it by a heavy horizontal line.

> *Interstate.*—This sign is provided for in the standards for the Interstate System, in 10-inch capital letters.

1D–41 Rest and Information Area Signs (D5, E5)

It is common practice on rural highways to provide roadside parks or rest areas where a traveler may stop safely away from passing traffic for rest or picnicking. It is desirable to erect signs a few hundred yards in advance of such areas to permit the driver to reduce speed and leave the highway safely if he desires to stop. Messages such as ROADSIDE REST 1000 FEET, PICNIC TABLE ¼ MILE, or ROADSIDE PARKING AREA ½ MILE are typical (D–5).

On controlled-access expressways, as a feature of highway design, there should be set aside special areas, with properly designed access roadways, to serve the comfort and convenience of the traveling public. At a distance of 1 to 2 miles in advance of such an area, there should be erected at the roadside a sign carrying the legend REST AREA, INFORMATION CENTER, SCENIC AREA, or similar appropriate message, with a second line showing the distance (E5). At or in advance of the beginning of the deceleration lane there should be placed a sign similar to the Exit Direction sign (sec. 1D–37), with an arrow or the words KEEP RIGHT (or LEFT), or RIGHT (or LEFT) LANE. Within the gore there should be a final sign with an arrow pointing in the appropriate direction. On these signs the legend should be in capital letters not less than 10 inches high.

Since these signs serve a special purpose for local information rather than for route guidance, they may warrant the use of a special design or color combination. An interchange of the legend and background colors prescribed for other guide signs has been suggested, or a different and distinctive color scheme, such as a blue background with white legend.

> *Interstate.*—Standards for the Interstate System prescribe the scheme of signs described above. The words REST AREA on the advance sign are in 16-inch capital letters, with the distance in a 16-inch numeral and 12-inch capital letters. The exit direction sign and the gore sign are in 12-inch capitals. Such signs shall have white legend on a blue background, with the legend, at least, reflectorized.

1D–42 Services Signs (E6, E7)

On high-type, controlled-access expressways, as a general rule, access to automotive service stations, restaurants, overnight lodgings and other commercial establishments is available only at interchanges or where a special service area or service roadways have been provided. It is often necessary, therefore, to indicate by signs where these facilities can be reached.

In an urban area where a built-up community is visible from the expressway, the driver can assume that any interchange exit will lead him to the services he needs within a reasonable distance, and Services signs are not ordinarily necessary. A similar situation exists where frontage roads are provided, but it may be desirable to give advance notice of access to the frontage road. Where services in rural areas are infrequent and perhaps difficult to reach, the Services sign may be very useful. Local conditions largely determine what will constitute a qualified establishment warranting a Services sign. Until generally acceptable policies and criteria have been developed by experience and research, each highway authority will have to make its own standards. In some locations signs may be needed to indicate that services are not available.

The Services sign (E6) should list the services available, limited to GAS, FOOD, LODGING, and PHONE, to the extent that they apply. As a general rule, a Phone sign is unnecessary at a location where a telephone is normally expected to be available. If the Services sign is not used as a supplemental sign in conjunction with the first of the advance interchange signs, it should carry such additional legend as NEXT EXIT or the appropriate mileage. The legend should be in capital letters of a minimum height of 8 inches. If desired the word SERVICES in larger letters may precede the listing of facilities.

If a public telephone is provided at a rest or information area, a supplementary plate carrying the legend PHONE may be mounted just below the Rest or Information Area sign.

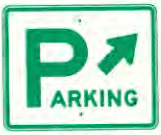
Where, at an exit providing service facilities, it is a long distance to the next available facilities, it may be desirable to provide a sign reading NEXT SERVICES (22) MILES (E7). An appropriate location for such a sign is below the Exit Direction sign at the beginning of the deceleration lane. **This sign shall be used only if preceded by a Services sign having reference to the immediate exit.**

Colors for Services signs should be the same as for Rest Area signs (sec. 1D–41).

Interstate.—Standards for the Interstate System provide for Services signs with legend as above described in 10-inch capital lettering, and with reflectorized white legend on a reflectorized or opaque blue background.

1D–43 Parking Area Sign (D4–1)

In a congested urban area where an off-street public parking lot or garage is available, it is often desirable to guide traffic to such a nearby facility, thus minimizing aimless travel on the part of drivers unacquainted with the area.



D4–1
30″ x 24″

The Parking Area sign may be used where it is desired to show the direction to a nearby public parking area. **The sign shall be a horizontal rectangle of a standard size of 30 inches by 24 inches with a smaller size for secondary, low-speed streets of 18 inches by 15 inches. It shall carry the word PARKING, with the letter P five times the height of the remaining letters, and a directional arrow. The legend shall be green on a white background.** If used, it should be erected on major thoroughfares at the nearest point of access to the parking facility and elsewhere where it can help relieve the local streets of traffic seeking a place to park. In general, it should not be used more than three or four blocks from the parking area. **It shall be mounted an accordance with the general specifications for the erection of signs (secs. 1A–22, 23).**

No warrants have been established for this sign in terms of the size of the parking facility, its accessibility, or whether a parking fee is charged. Local traffic authorities will have to determine the need for it under the conditions existing in the area concerned. Under some circumstances the sign may be useful in rural areas where crowds congregate for special events.

1D–44 Other Directional Signs

The guide signs described above cover most of the traveler's needs, but other signs may be used where they can provide additional useful directions. Nearby destinations not shown on expressway interchange advance signs may be shown on a special sign carrying up to three additional names and the legend NEXT EXIT, NEXT RIGHT, or SECOND RIGHT, erected about 1½ miles in advance of the interchange.

> *Interstate.*—Signs of the above type are provided for in the standards for the Interstate System. They list up to two destinations, with the legend NEXT RIGHT or SECOND RIGHT, and are placed approximately midway between the advance exit signs if two are used. If only one advance exit sign is used the supplemental destination sign shall follow it by at least 800 feet.

Some expressways pass through historical, recreational, or metropolitan regions, or other areas of special interest served generally by a succession of several interchanges. Such areas may be indicated by a special sign several miles, if possible, in advance of the Advance Exit guide sign or signs for the first interchange, carrying a suitable legend to identify the region, followed by the words NEXT (3) EXITS or NEXT (3) INTERCHANGES where appropriate.

> *Interstate.*—Signs of the above type are provided for in the standards for the Interstate System.

1D–45 Mileposts

To assist the driver in estimating his progress, to provide a means for identifying the location of emergency incidents, and to aid in highway maintenance and servicing, Mileposts may be erected along any section of a numbered highway route. It is recommended that these be simple panels, without border, having 4- to 6-inch numerals and no other legend. The numerals should be black on a white background or white on a green or black background, with suitable reflectorization. The Mileposts should be placed on the shoulder edge or 2 feet back from the face of any curb. If physical conditions prevent the placement of a Milepost at its correct location, it may be moved in either direction as much as 50 feet, or, if it cannot be placed within that degree of accuracy, it should be omitted. "Zero" mileage for any given route must be determined by the highway authorities in a manner appropriate to the highway network.

> *Interstate.*—On the Interstate System it is prescribed that Mileposts shall be installed as above described on both sides of the highway, with zero mileage at south or west State lines, or at junctions where routes begin. The mileage numbering is to be continuous within any State. The Milepost panels are green, with 6-inch white reflectorized numerals.

1D–46 Information Signs

Of interest to the traveler, though not directly necessary for his guidance, are numerous kinds of information that may

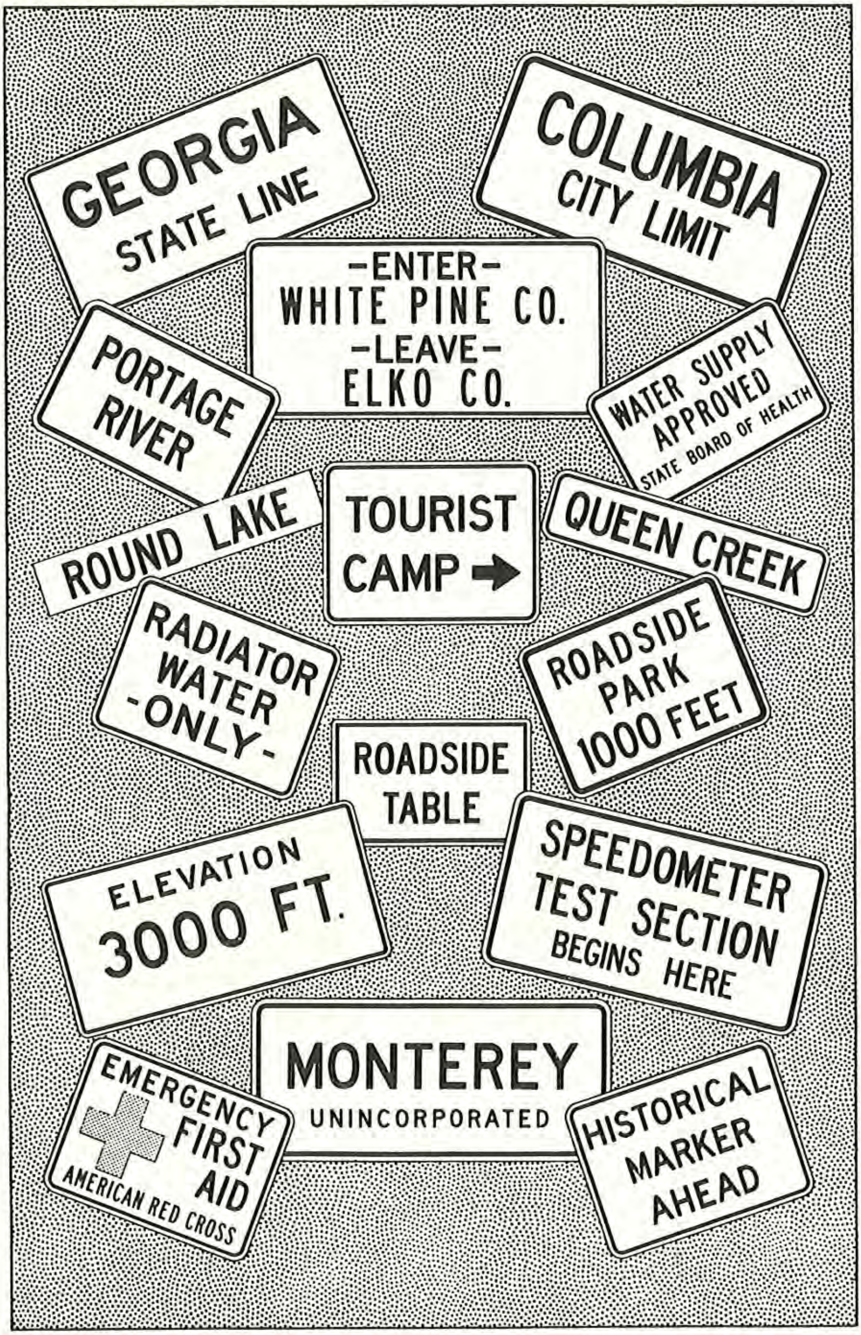

GEORGIA
STATE LINE
COLUMBIA
CITY LIMIT
-ENTER-
WHITE PINE CO.
-LEAVE-
ELKO CO.
PORTAGE
RIVER
WATER SUPPLY
APPROVED
STATE BOARD OF HEALTH
ROUND LAKE
TOURIST
CAMP
QUEEN CREEK
RADIATOR
WATER
-ONLY-
ROADSIDE
PARK
1000 FEET
ROADSIDE
TABLE
ELEVATION
3000 FT.
SPEEDOMETER
TEST SECTION
BEGINS HERE
MONTEREY
UNINCORPORATED
EMERGENCY
FIRST
AID
AMERICAN RED CROSS
HISTORICAL
MARKER
AHEAD

Figure 1–9. Typical information signs, selected from State highway department manuals.

properly be conveyed by information signs. They include such information as State lines, city limits, and other political boundaries, stream names, elevations, landmarks, scenic views, and similar items of geographical or cultural interest. Such signs should conform to the general standards for guide signs, and be large enough for adequate legibility. Since they are for information purposes and do not ordinarily serve to regulate, warn, or guide traffic (except perhaps indirectly as in the case of city limits) the need for uniformity in design to insure automatic response is not altogether essential. Typical signs of this type are shown in figure 1–9.

These signs shall be erected in accordance with the general specifications for sign erection (secs. 1A–22, 23). On expressways they should where practicable be spaced at least 800 feet from any other guide signs.

> *Interstate.*—On the Interstate System it is prescribed that place names and stream names on such information signs shall be in 6-inch lower-case letters with 8-inch initial capitals. Generic words such as CITY LIMITS shall be in 6-inch capital letters. The legend shall be in reflectorized white on an opaque or reflectorized ~~blue~~ green background.

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Part II

MARKINGS

A—INTRODUCTION AND GENERAL SPECIFICATIONS

Section 2A–1 Functions and Limitations of Markings

Markings have definite and important functions to perform in a proper scheme of traffic control. In some cases they are used to supplement the regulations or warnings of other devices such as traffic signs or signals. In other instances they obtain results, solely on their own merits, that cannot be obtained by the use of any other device. In such cases they serve as a very effective means of conveying certain regulations and warnings that could not otherwise be made clearly understandable.

Pavement markings have definite limitations. They may be entirely obliterated by snow, are not clearly visible when wet, and are not very durable when painted on surfaces exposed to traffic wear. In spite of these limitations they have the advantage, under favorable conditions, of conveying warnings or information to the driver without diverting his attention from the roadway.

Pavement markings that are otherwise warranted or prescribed cannot, of course, be applied to unpaved roadways.

2A–2 Legal Authority

Markings shall be placed only by the authority of a public body or official having jurisdiction for the purpose of regulating, warning, or guiding traffic.

Pavement and curb markings, being exclusively within the boundaries of public highways, should never be installed except under public authority. Delineators and markings on objects as a warning of their hazardous locations are also normally within the highway right-of-way, and should be subject to the same jurisdictional regulations.

A suitable model for the legal authority for the placing of markings is presented in the Uniform Vehicle Code (secs. 1–139, 11–201, 11–205, 15–104, 15–105, 15–106). Interference with official markings is prohibited in section 11–206 of the same code.

2A–3 Standardization

Markings shall be uniform in design, position, and application. As in the case of all other traffic control devices, it is imperative that markings be uniform so that they may be recognized and understood instantly by all drivers.

2A–4 Types of Markings

Markings as defined for the purposes of this manual are of a number of types:

1. Pavement Markings:
   - (a) Center lines (secs. 2B–1, 2, 3).
   - (b) Lane lines (secs. 2B–4, 5, 6).
   - (c) No-passing-zone markings (secs. 2B–7 to 10).
   - (d) Pavement edge lines (secs. 2B–11, 12, 13).
   - (e) Paved-shoulder markings (sec. 2B–12).
   - (f) Pavement-width transitions (sec. 2B–14).
   - (g) Channelizing lines (secs. 2B–15, 16).
   - (h) Approaches to obstructions (secs. 2B–17, 18).
   - (i) Turn markings (sec. 2B–19).
   - (j) Stop lines (sec. 2B–21).
   - (k) Crosswalk lines (sec. 2B–22).
   - (l) Approaches to railroad crossings (sec. 2B–23).
   - (m) Parking space limits (sec. 2B–24).
   - (n) Word and symbol markings (sec. 2B–25).
   - (o) Lane-use control markings (sec. 2B–26).
2. Curb markings for parking restrictions (sec. 2B–27).
3. Object markings:
   - (a) Objects within the roadway (secs. 2C–2, 3, 4).
   - (b) Objects adjacent to the roadway (sec. 2C–5).
4. Reflector markers:
   - (a) Hazard markers (sec. 2D–2).
   - (b) Delineators (secs. 2D–3, 4, 5).

2A–5 Materials

The most common method of placing pavement, curb, and object markings is by means of paint. A continuous improvement in paints and in equipment and methods of application has resulted in a very extensive use of pavement markings. Equipment in general use is capable of placing single, double, or triple lines on a highway, solid or broken, in different colors, while operating at a speed of 6 to 10 miles per hour. Small self-propelled stripers are available that can lay a triple line, but their operating speed is only about 1½ miles per hour. The chief advantage of these small machines is that they can be readily transported to isolated projects in a light truck. Hand equipment can be used to place transverse or special markings, at intersections or elsewhere, at a reasonable cost.

The night visibility of pavement markings is increased by the use of minute glass "beads" (actually true spheres) embedded in the pavement-marking material to produce a retrodirective reflecting surface.

The glass-beaded surface reflects a high proportion of the incident light from headlamps directly back toward its source in a narrow cone having enough divergence to reach the driver's eyes in his normal position above the headlamps, thereby causing the markings to appear luminous at night. Although the initial cost of such reflectorized markings is higher than for ordinary traffic paint, a number of highway departments have reported that the increased life of the markings, especially at heavily-traveled locations, more than compensates for the difference in cost.

Thermoplastic materials for pavement marking are finding increased use at locations subject to extreme traffic wear. Experience at heavy-traffic locations has indicated an average service life equivalent to eight applications of beaded traffic paint. **Thermoplastic markings shall conform to the color, reflectorization, and dimension specifications for paint markings.**

Flat units on or in the pavement surface shall be of permanent color as specified for pavement markings, and shall be set so that their upper surfaces are essentially flush with the pavement surface. They may be placed in continuous contact, or separated by small spaces approximately equal to the length of a single unit. Either type of line may be used where a solid line is prescribed in this manual. To insure a good appearance, particular care should be taken to see that alinement and spacing are accurate.

Metal inserts shall have a surface that will remain bright under the action of traffic, thus contrasting with the color of the pavement. Nonmetallic inserts shall be of permanent colors as specified for pavement markings. Inserts shall be not less than 4 inches in diameter if round, or of equivalent minimum area if of other shape, and shall be spaced not more than 16 inches apart, center to center, add below **They shall have rounded surfaces, presenting a smooth contour to the wheels of vehicles, and shall not project more than three-fourths inch above the level of the pavement. They shall be permanently fixed in place by anchor bolts, adhesive, or similar effective means.**

The epoxy resin adhesives have proved extremely effective in attaching plastic or cement-bonded inserts to concrete or asphaltic pavements. These adhesives harden in from 15 to 30 minutes so that final mixing must be done on the job. To insure an effective bond, the pavement should be spot sandblasted or wire brushed and blown free of dust and loose materials.

add ... , on transverse lines, and not more than 36" apart on longitudinal lines. Re: ITE Feb. 62 pg 27

Unit letters, symbols, or stripes may be attached to or set into the pavement surface, as an alternative type of pavement marking. These should be essentially flush with the pavement surface, and should not become unduly slippery when wet. **They shall be of permanent colors as specified for pavement markings.**

Metal and plastic inserts and flat marker units in or on the pavement surface are used principally in urban areas, where heavy traffic rapidly destroys painted markings, and frequent repainting not only is costly but causes undue traffic delays. In rural areas speed of application makes painting the preferred form of marking.

While successful experiments have been reported with permanent built-in pavement markings of white or colored concrete or inlaid bricks or blocks, they are not adaptable to reflectorization nor to any change in layout for altered traffic conditions, and their use is not recommended.

The use on the pavement surface of small metal or plastic studs with inserted reflector buttons is not recommended. Experience has shown that they are destroyed by snow plows, they cannot be kept clean and effective, and they are a hazard to motorcycles.

Large "mushroom" buttons, or bars, of cast iron or concrete several inches high, with or without reflectors, lights, symbols, or messages, should not be used for pavement markings. They are sometimes used to designate pedestrian islands or to assist in channelizing traffic. In these applications they are, in effect, curbs or islands, and they should be restricted to such applications (part IV). They should not be located where they constitute an unexpected hazard for motor vehicles. The use of raised bars (commonly known as "jiggle bars") to discourage the use of certain pavement areas (sec. 4A–3) can be effective, provided that such bars are not so high as to cause hazard or damage.

Object markings are ordinarily painted directly on the surface of the obstruction. If the surface will not retain paint satisfactorily, some flat surface of wood or metal should be painted with the proper marking and attached to the obstruction. Where a reflectorized coating is desirable it will often be necessary to use a separate surface for satisfactory application. Reflecting buttons or clusters may be attached directly to the obstruction or installed on separate posts immediately in front of it.

Delineators and hazard markers may consist of single reflectors, clusters of reflectors, or small panels of uniform shape covered with a reflecting coating, mounted on separate posts (secs. 2D–2, 2D–4). To be effective they must be of retrodirective character and of adequate brilliance.

2A–6 Colors

Pavement markings shall be white or yellow in color. The use of black in the gaps of a broken pavement line is permissible where the pavement itself does not provide sufficient contrast. This use of black does not establish it as a standard color for pavement markings, but is only a means of achieving contrast on a light colored pavement.

The correct color for yellow traffic paint is the same as that specified for highway signs.[10]

White shall be used for:

1. Center lines on two-lane rural roads and city streets.
2. Lane lines.
3. Pavement edge lines.
4. Paved-shoulder markings.
5. Channelizing lines.
6. Approaches to obstructions which may be passed on either side.
7. Turn markings.
8. Stop lines.
9. Crosswalk lines.
10. Parking space limit lines.
11. Word and symbol markings.

Yellow shall be used for:

1. Double center lines on multilaned pavements.
2. No-passing barrier lines at:
   (a) No-passing zones on two- and three-lane roads.
   (b) Pavement-width transitions.
   (c) Approaches to obstructions which must be passed on the right.
   (d) Approaches to railroad crossings.
3. Curb markings:
   (a) To show parking prohibitions covered by signs or ordinance.
   (b) On islands in the line of traffic.

Yellow is prescribed for the markings indicated for several reasons: (1) It contrasts with the normal white center or lane lines and thus gives emphasis to the hazard; (2) Yellow has been accepted as a symbolic warning color in signs and signals; and (3) It is consistent with the standard for no-passing-zone markings approved by the American Association of State Highway Officials and is in use in more than two-thirds of the States for barrier lines.

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[10] Color cards showing this "highway yellow" may be obtained from the Bureau of Public Roads on request.

Markings on vertical surfaces of objects within the roadway or dangerously close thereto may consist of alternate black and white stripes, or the surface may be painted white. **All white areas shall be reflectorized.**

Objects adjacent to the roadway, such as guardrails, trees, and rocks, may be painted white as a useful guide to night traffic.

Roadway delineators shall be white, except that yellow delineators may be used to mark expressway ramps in interchange areas. Hazard Markers (including clearance markers) shall be yellow or striped black and white.

2A–7 Types of Lines

A broken line shall be used for the center lines on two-lane rural roads and for lane lines, where these lines are only guide lines that may be crossed at the discretion of the driver. Center lines are of great importance for the guidance of drivers and to help separate traffic proceeding in opposite directions. On two-lane rural roads these objectives can be satisfactorily accomplished, with economy, by the use of broken lines. Similarly, lane lines which help keep vehicles traveling in the same direction in their proper lateral positions should be marked by broken lines.

A broken line, with segments and gaps well proportioned, is as effective as a solid line for guide purposes. The standard ratio of stripe to gap is 3 to 5. On rural highways, a commonly used standard is 15-foot segments with 25-foot gaps. However, on mountain or other roads with many short-radius curves, 9-foot segments with 15-foot gaps will maintain better continuity, particularly where maintenance patching occasionally eliminates a line segment. In the application of a given gallonage of paint per mile, such relatively short segments (9 to 15 feet) will give a better line than if longer segments, with correspondingly longer gaps, are used.

On urban streets the line segments and gaps may be considerably reduced in length but the 3 to 5 ratio of stripe to gap should be maintained.

High-speed striping machines have been constructed that are capable of repainting broken lines accurately and neatly.

A broken line permits a saving of more than 60 percent in the amount of paint required, as compared with a solid line, with little or no increase in the cost of application.

Solid white lines are used for guide lines where the line may not ordinarily be crossed at the discretion of the driver or where crossing of the line is to be discouraged. These include center lines on city streets, channelizing lines, pavement edge lines, and approach markings to obstructions which may be passed on either side. Transverse pavement lines are also solid white lines.

Solid yellow lines are used for guide or regulatory lines to the left of which it is unsafe or illegal to travel. Where a combination solid and broken line is used, the solid yellow, or barrier, line has significance only if it is on the right-hand side of the combination line, as viewed by the driver, i.e., in or adjacent to the traffic lane to which it applies.

2A–8 Width of Lines

Center lines, lane lines, and barrier lines shall be 4 to 6 inches wide. The most common width is 4 inches, but 6-inch lines, favored by a number of highway departments, provide added visibility. Narrower 3-inch lines have been used as a means of economizing in paint, but they are not recommended.

The width of a channelizing line (sec. 2B–15) may vary from the normal line width (4 to 6 inches) to a maximum of 12 inches, depending on the emphasis required.

Pavement edge lines shall be 2 to 4 inches wide.

Transverse lines on pavements must be much wider than longitudinal lines to be equally visible. Stop lines may have to be as wide as 24 inches where approach speeds are high.

2A–9 Reflectorization

All pavement markings having application at night shall be reflectorized. Reflectorization is not ordinarily essential where high-level illumination is present, but even on well lighted city streets it is generally desirable that markings which must be visible at night be reflectorized.

2A–10 Maintenance

All markings shall be maintained in effective condition at all times.

The frequency of repainting depends on the type of surface, composition and rate of application of paint, climate, and volume of traffic. Particular care should be taken, expecially in the case of broken lines, to paint over the old markings as exactly as possible. Otherwise they will appear increasingly ragged after successive repaintings.

B—PAVEMENT AND CURB MARKINGS

Section 2B–1 Center Lines

A center line is used to designate the center of the traveled part of a roadway carrying traffic in both directions. Under some circumstances, as at a pavement-width transition, or where an extra uphill traffic lane is provided, it need not be at the geometrical center of the pavement. On all major rural highways having an even number of lanes, and on many urban streets and less important rural roads, center lines are necessary and should be applied throughout the entire length of the pavement. In urban locations and on some rural roads where a continuous center line is not required, short sections of center line are useful on approaches to busy intersections, marked crosswalks, or railroad crossings, and around curves or over hillcrests. When so used, the center line serves both to warn of any unusual condition and to organize and control traffic through a hazardous or congested zone.

Lines dividing a one-way roadway into two or more lanes are lane lines (sec. 2B–4).

2B–2 Center Lines on Rural Roads

The center line on a two-lane paved rural highway shall be a broken white line, not less than 4 nor more than 6 inches wide. Where a solid channelizing line (sec. 2B–15) is used as a center line, however, the width of the solid line may vary from the normal line width to a maximum of 12 inches, depending on the emphasis required. Line segments having a 3 to 5 ratio of stripe to gap are standard and segments 15 feet in length, with 25-foot gaps, are recommended.

On four-lane undivided rural pavements, or on pavements of a greater even number of lanes, the center line shall consist of two solid yellow lines, each not less than 4 inches nor more than 6 inches wide, separated by a space of not less than 3 inches.

Since this center line is, in effect, a continuous no-passing line to the left of which it is, under the Uniform Vehicle Code and the laws of many States, illegal to drive (sec. 2B–7), it is logical that the two lines should be yellow.

As a guide to the application of center-line markings, the following warrants are suggested:

1. Center lines are desirable on all paved highways and as a minimum should be placed throughout the length of:
   - (a) Two-lane pavements carrying average annual traffic volumes in excess of 1,000 vehicles per day.
   - (b) Two-lane pavements narrower than 20 feet carrying average annual volumes in excess of 500 vehicles per day.
   - (c) Two-lane pavements narrower than 18 feet but not less than 16 feet in width carrying average annual volumes

in excess of 300 vehicles per day. Center lines should not be used on pavements narrower than 16 feet.

(d) All four- , six- , and eight-lane undivided pavements.

2. Center lines should be placed at other locations where the accident record indicates the need for them, and on hard-surfaced roads in areas where driver visibility is likely to be reduced frequently, as by fog.

2B–3 Center Lines on Urban Streets

The center line on a two-way city street with less than four lanes for moving traffic at any time shall be a solid white line. Such a line shall be not less than 4 nor more than 6 inches wide. For increased emphasis, a wider channelizing line may be used for the center line (sec. 2B–15). ?

The center line on a two-way street with four or more lanes for moving traffic at all times shall be a double solid yellow line except on a street involving reversible lane control. In such case a single solid white line (sec. 2B-15) may be used. ?

A line marking the center of a one-way street is a lane line and shall be a broken white line.

Applications of center lines are shown in various illustrations herein, particularly figures 1–8, 2–1, and 2–4.

2B–4 Lane Lines

Lane lines are helpful in the organization of traffic in its proper channels, and in increasing the efficiency of the use of the roadway surface at congested locations. They should be used:

1. On all rural highways with an odd number of traffic lanes.

2. In addition to the double solid center line, on all undivided rural highways of four or more lanes.

3. At the approaches to important intersections and crosswalks, and in dangerous locations, on both rural highways and city streets.

4. At congested locations, particularly on city streets, where the roadway will accommodate more lanes of traffic than would be the case without the use of lane lines. These include:

(a) Locations between loadings islands and sidewalk curbs.

(b) Other locations where the normal lane width is decreased.

(c) Approaches to widened intersections.

5. On one-way streets or roadways where maximum efficiency in utilization of the roadway is desired.

Applications of lane lines are illustrated in figures 2–3 to 2–8, and 2–11.

2B–5 Lane Lines on Rural Roads

Lane lines on rural roads shall be broken white lines, not less than 4 inches nor more than 6 inches wide. Line segments 15 feet long, with 25-foot gaps, are recommended. A solid channelizing line (sec. 2B–15) used in place of a lane line may vary in width from the normal line width to a maximum of 12 inches. The transverse spacing of lane lines, that is, the lane width, should not normally be less than 10 feet, with 12 feet as the desirable width.

2B–6 Lane Lines on Urban Streets

Lane lines on city streets shall be broken white lines, not less than 4 inches nor more than 6 inches wide. Due to relatively lower speeds, the line segments and gaps may be shorter than in rural areas, maintaining a 3 to 5 ratio of length of stripe to length of gap. A solid channelizing line (sec. 2B–15) used in place of a lane line may vary in width from the normal line width to a maximum of 12 inches.

The lane width defined by lane lines should not normally be less than 10 feet, but a minimum of 9 feet is permissible where a maximum number of lanes must be made available, as at a signalized intersection where provision must be made for the most efficient storage of stopped vehicles.

On wide, high-speed boulevards and on controlled-access highways in urban areas the standards for lane markings shall be the same as those for rural highways.

2B–7 No-Passing Zones

No-passing zones shall be established at vertical and horizontal curves and elsewhere on two- and three-lane highways, where passing must be prohibited because of dangerously restricted sight distances or other hazardous conditions.

The legal basis for the establishment of no-passing zones is set forth in section 11–307 of the Uniform Vehicle Code as follows:

(a) The (State highway commission) is hereby authorized to determine those portions of any highway where overtaking and passing or driving to the left of the roadway would be especially hazardous and may by appropriate signs or markings on the roadway indicate the beginning and end of such zones, and when such signs or markings are in place and clearly visible to an ordinarily observant person every driver of a vehicle shall obey the directions thereof.

(b) Where signs or markings are in place to define a no-passing zone as set forth in paragraph (a) no driver shall at any time drive on the left side of the roadway within such no-passing zone or on the left side of any pavement striping designed to mark such no-passing zone throughout its length.

2B–8 No-Passing Zone Markings

A no-passing zone shall be marked by a solid barrier line placed as the right-hand element of a combination line along the center or lane line. This barrier line shall be yellow.

The barrier line shall be not less than 4 nor more than 6 inches wide, and shall be separated from the adjacent line by a space of not less than 3 nor more than 4 inches.

The combination line shall consist of either of the following, as illustrated in figure 2–1:

1. **A normal broken white center or lane line continuing through the no-passing zone, with the solid yellow barrier line placed to the right of it.** Where no-passing zones in opposite directions overlap on a two-lane roadway there will be a solid yellow barrier line on each side of the broken white center line. Where the no-passing restriction applies only in the opposing direction, the barrier line will appear to the left of the broken center or lane line.
2. **A double line, of which the right-hand line is a solid yellow barrier line.** The left-hand line will be either a normal broken white center line or a solid yellow barrier line governing the opposing direction of traffic. Where the solid yellow barrier line is on the left of a broken white line the passing restriction will apply only to the opposing direction of traffic.

2B–9 Application of No-Passing Zone Markings

On a two-lane highway the combination no-passing line shall follow the center line throughout the no-passing zone. On a three-lane highway the combination line shall start in advance of the no-passing zone at the left-hand lane line of the center lane and shall extend diagonally across the center lane to the right-hand lane line at the beginning of the no-passing zone, and thence extend along the lane line to the end of the zone (fig. 2–1). The combination line shall extend across the center lane at an angle of not less than 20 to 1 where the offpeak 85-percentile speed is 40 m.p.h. or less, and at least 30 to 1 where speeds are greater than 40 m.p.h.

No-passing-zone signs (secs. 1B–21, 22) may be used to emphasize the existence and extent of a no-passing zone, in addition to the pavement markings here prescribed.

In no case shall the marking be less than 500 feet in length. If the actual no-passing distance is less than 500 feet, the ad-

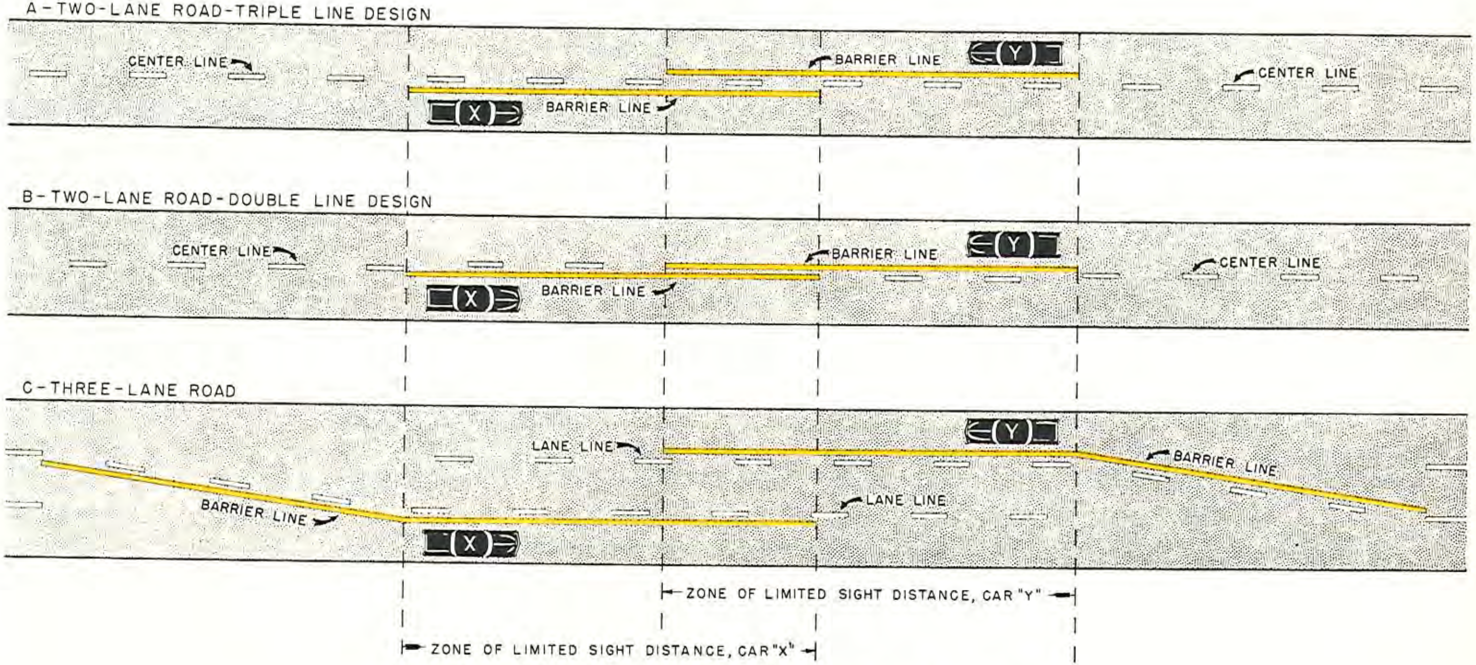

A-TWO-LANE ROAD-TRIPLE LINE DESIGN
CENTER LINE
BARRIER LINE
Y
X
BARRIER LINE
CENTER LINE
B-TWO-LANE ROAD-DOUBLE LINE DESIGN
CENTER LINE
BARRIER LINE
Y
X
BARRIER LINE
CENTER LINE
C-THREE-LANE ROAD
LANE LINE
Y
BARRIER LINE
LANE LINE
BARRIER LINE
X
ZONE OF LIMITED SIGHT DISTANCE, CAR "Y"
ZONE OF LIMITED SIGHT DISTANCE, CAR "X"

Figure 2–1. **Standard pavement markings for no-passing zones.**

ditional length of marking shall be added at the beginning of the zone. Less than 400 feet of distance between successive no-passing zones is not sufficient for unrestricted passing. In such cases, the one-direction barrier line, or the two-direction barrier line, whichever is appropriate, should connect the zones.

It is assumed that on two-way roadways of four or a greater even number of lanes it is not necessary to cross the center line to overtake and pass other vehicles. The double yellow center line prescribed for such highways is to be regarded as a continuous no-passing marking, which must not be crossed from either side.

On urban streets it is not ordinarily necessary to mark no-passing zones. Speeds are generally low, and a center line is usually sufficient to keep vehicles in line. On boulevards or parkways, where no-passing zones may have to be marked, the standards should be the same as for rural highways.

The no-passing barrier line is also used on two-way roadways at pavement-width transitions (sec. 2B–14) and on approaches to obstructions which must be passed on the right (sec. 2B–18). It may also be used on approaches to intersections.

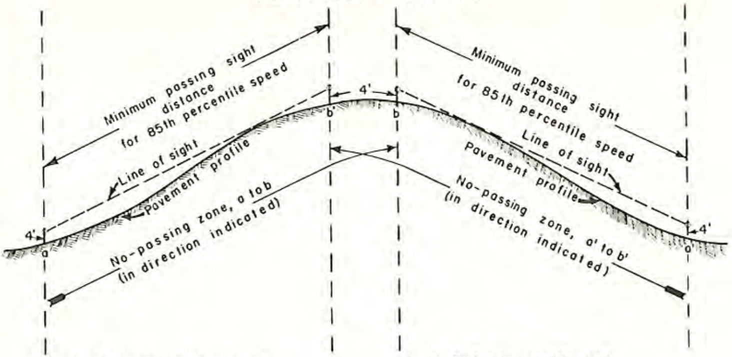
2B–10 Warrants for No-Passing Zones at Curves

A no-passing zone at a horizontal or vertical curve is warranted where the sight distance as defined below is less than the minimum necessary for safe passing at the prevailing speed of traffic. Sight distance on a vertical curve is the distance at which an object 4 feet above the pavement surface can just be seen from another point 4 feet above the pavement, as illustrated in figure 2–2. Similarly sight distance on a horizontal curve is the distance measured along the center line (or right-hand lane line of a three-lane highway) between two points 4 feet above the pavement on a line tangent to the embankment or other obstruction that cuts off the view on the inside of the curve (fig. 2–2). **A curve shall warrant a no-passing zone and shall be so marked where the sight distance is equal to or less than that listed below for the prevailing (offpeak) 85-percentile speed:**

85-percentile speed (m.p.h.):	*Minimum sight distance (feet):*
30	500
40	600
50	800
60	1,000
70	1,200

The beginning of a no-passing zone (point *a* in figure 2–2) is that point at which the sight distance first becomes less than that

VERTICAL CURVE


Minimum passing sight distance for 85th percentile speed
Minimum passing sight distance for 85th percentile speed
4'
4'
4'
Line of sight
Pavement profile
Line of sight
Pavement profile
a
b'
b
a'
No-passing zone, a to b (in direction indicated)
No-passing zone, a' to b' (in direction indicated)

a, a' Begin no-passing zone

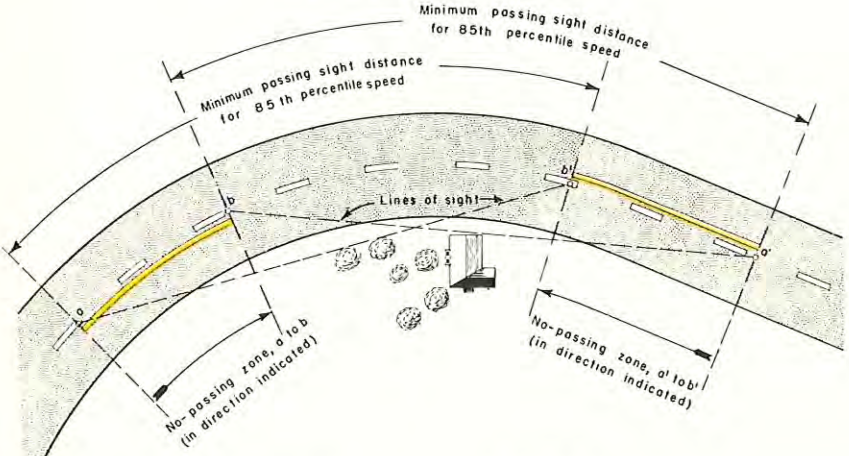
Sight distance becomes less than minimum measured between points 4 feet above pavement

b, b' End no-passing zone

Sight distance again exceeds minimum

Note: No-passing zones in opposite directions may or may not overlap, depending on alinement.

HORIZONTAL CURVE


Minimum passing sight distance for 85th percentile speed
Minimum passing sight distance for 85th percentile speed
Lines of sight
a
b
b'
a'
No-passing zone, a to b (in direction indicated)
No-passing zone, a' to b' (in direction indicated)

a, a' Begin no-passing zone

Sight distance, measured along center line (or right-hand lane line on three lane road) becomes less than minimum

b, b' End no-passing zone

Sight distance again exceeds minimum

Note: No-passing zones in opposite directions may or may not overlap, depending on alinement.

Figure 2–2. Method of locating and determining the limits of no-passing zones at vertical and horizontal curves.

specified in the above table. The end of the zone (point *b*) is that point at which the sight distance again becomes greater than the minimum specified.

2B–11 Pavement Edge Lines

Pavement edge lines shall be solid white lines not less than 2 inches nor more than 4 inches wide. They shall be used only as a supplement to and not as a substitute for standard center and lane lines. Pavement edge lines are not a substitute for adequate road delineation markers.

The purpose of line markings on the edge of the pavement is generally threefold: (1) to reduce travel, particularly by the heavier vehicles, on shoulders of lesser structural capacity than the adjacent pavement, (2) to make driving more comfortable, particularly at night and during inclement weather, by providing a continuous guide for the driver, and (3) to reduce accidents.

2B–12 Right-Hand Edge Line and Paved-Shoulder Markings

The shoulder area on various types of highways varies greatly in both width and character, ranging from narrow and unpaved, not suitable for driving in emergencies, to high-type paved shoulders 10 feet or more in width.

The varied conditions require different edge-marking treatment. Insofar as possible, uniformity must be maintained. However, exactly the same treatment cannot be applied to all conditions of pavement edge and shoulder.

The need for placing a pavement edge marking also varies with the character of the pavement edge and the shoulder. The several conditions generally encountered are treated separately as follows:

1. *No shoulder or unsurfaced shoulder.*—Under these conditions, pavement margins are sometimes raveled and broken. The shoulder is frequently rough and unsafe for emergency use except at low speeds. With adverse light and weather, it is often difficult to distinguish the exact edge of the pavement.

With the unsurfaced shoulder, there is no evidence that edge lines have been mistaken for lane lines. The unpaved shoulder condition with the probability of roughness, loose material, or a drop-off at the pavement edge is a strong warrant for the use of a pavement edge line.

2. *Paved shoulders.*—Pavement edge marking presents a special problem where the pavement surfacing is extended over part or all of the shoulder width.

The most effective means of differentiating paved shoulders from the traffic lanes is by a definite contrast in surface appearance, riding characteristics, and texture. The through traffic lanes and the shoulder area should be clearly defined at all times, particularly at night or in inclement weather when visibility is poor. This can best be accomplished by a design which specifies contrasting color and texture. Relatively coarse stone chips for the shoulder treatment are desirable to provide an audible warning to the driver as well as the contrast in color and texture.

Where the contrast is sharp enough there is no need for a line marking to indicate the edge of the traffic lane. However, there is no objection to its use if required for uniformity in areas where pavement edge markings are in general use.

Where the contrast is not sharp and the paved shoulder is 8 feet or less in width, the appearance of a traffic lane can be avoided to a considerable extent by placing the edge marking on the shoulder 1 to 2 feet from the edge of the traffic lane. This reduces the apparent width of the paved portion of the shoulder sufficiently to discourage its use as a driving lane. With a paved shoulder less than 8 feet in width, structurally adequate to carry all traffic, presenting no hazard due to stopped vehicles, and where it is not objectionable for traffic to encroach slightly on the shoulder, there is little evidence of need for edge striping; it may, however, be provided as an additional guide to drivers.

Where the contrast is not sharp and the paved shoulder is more than 8 feet in width, the problem is accentuated. Under these conditions, a line marking at the edge of the traffic lane causes the shoulder to appear to the driver as another lane for traffic. There is definite evidence of confusion under these conditions. Wherever there are wide shoulders with no sharp contrast between through lanes and shoulder, a hazard may exist due to stopped vehicles being hit by vehicles which wander onto the shoulder. Special treatment is required if moving traffic is to be confined to the traffic lane. Such conditions are a strong warrant for use of shoulder delineation with diagonal lines.

The pavement edge line under these conditions should be placed on the shoulder 1 foot from the theoretical traffic lane, with diagonal markings on the shoulder to show definitely that it is not intended for use as a traffic lane. These diagonal markings should be 12 inches in width with spacing varied from 20 feet in low speed areas to 100 feet in areas where operating speeds are 50 miles per hour or over.

A typical layout for these shoulder markings is shown in figure 2–3.

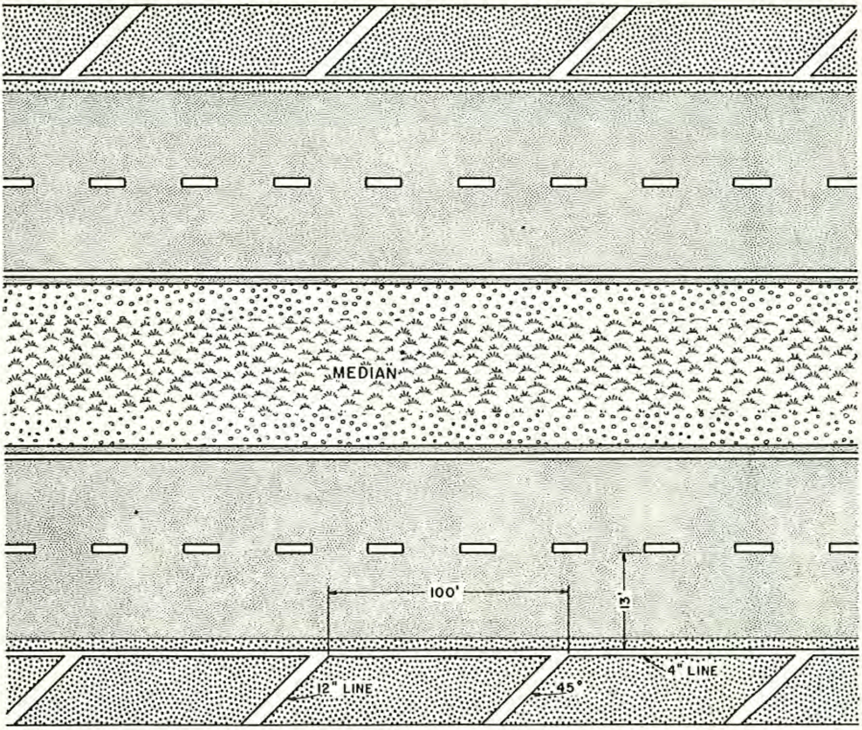


Figure 2–3. Typical paved-shoulder markings on wide paved shoulder with surface texture, riding quality, and color similar to traffic lanes.

2B–13 Left-Hand Edge Line

On a one-way roadway, a left-hand edge line frequently is helpful. This line marking should normally be a single solid white line 4 inches in width. This type of marking is an effective means of delimiting the median area of a divided highway (fig. 2–3). Where special emphasis is required adjacent to curbs, in areas of poor visibility, or on medians less than 16 feet in width the double yellow barrier line or solid channelizing line should be used. **Where the median is paved flush with the traffic lanes, the double barrier line shall be used in all cases.**

2B–14 Pavement-Width Transitions

Line markings should be used to guide traffic at points where the pavement width changes to a lesser number of lanes. **Line markings at pavement-width transitions shall be not less than 4 nor more than 6 inches wide and of standard design for center, lane, or barrier lines. Converging lines shall have a length of not less than that determined by the formula L = S x W, where**

L equals the length in feet, S the (offpeak) 85-percentile speed in miles per hour, and W the offset distance in feet. On new construction, where no 85-percentile speed exists, the design speed may be used.

A number of situations are possible, as illustrated in figure 2–4, depending on which lanes must be offset or cut out, and the amount of offset. One or more lane lines must be discontinued, and the remaining center and lane lines must be connected in such a way as to merge traffic into the reduced number of lanes.

Through the transition area, in the direction of convergence, the line separating the opposing directions of traffic should be of no-passing-zone design, either the double solid center line of a multilaned road or a normal broken center line with an adjacent barrier line as prescribed for no-passing zones (sec. 2B–8).

Line markings at pavement-width transitions are not sufficient, in themselves, to guide traffic safely through such locations. Standard signs, and guardrails, edge lines, or delineators (sec. 2D–4) must be used in conjunction with the pavement markings.

2B–15 Channelizing Line

The channelizing line shall be a solid white line. The width of the line may vary from the width of a normal center or lane line to a maximum of 12 inches depending on conditions and the emphasis required. Generally, 8 to 12 inches is desirable.

The wide solid traffic line is a useful traffic control device for channelizing traffic and discouraging lane changing. This device is used where traffic may proceed on either side, but where crossing the line is to be discouraged even if not legally prohibited.

The channelizing line is useful to form traffic islands in a paved area and to separate turn lanes from the main traffic lanes, where a more restrictive barrier, such as a curb, is impractical or would create a hazard. The wide line will outline a neutral area and guide traffic, but the consequences are not severe if it is driven over inadvertently or to avoid an accident. The use of this marking is, of course, limited to locations where a positive restriction in the form of a physical barrier is not required.

The solid line may be used in lieu of the broken lane line to accentuate the lane marking in critical areas and more clearly define the traffic lanes where it is advisable to discourage lane changing. Typical locations for use of this marking are tunnels where width is restricted, interchange areas where unnecessary lane changing is detrimental to smooth traffic flow, and areas where visibility is poor due to weather conditions. The solid lane line is applicable to both one-way and two-way roadways.

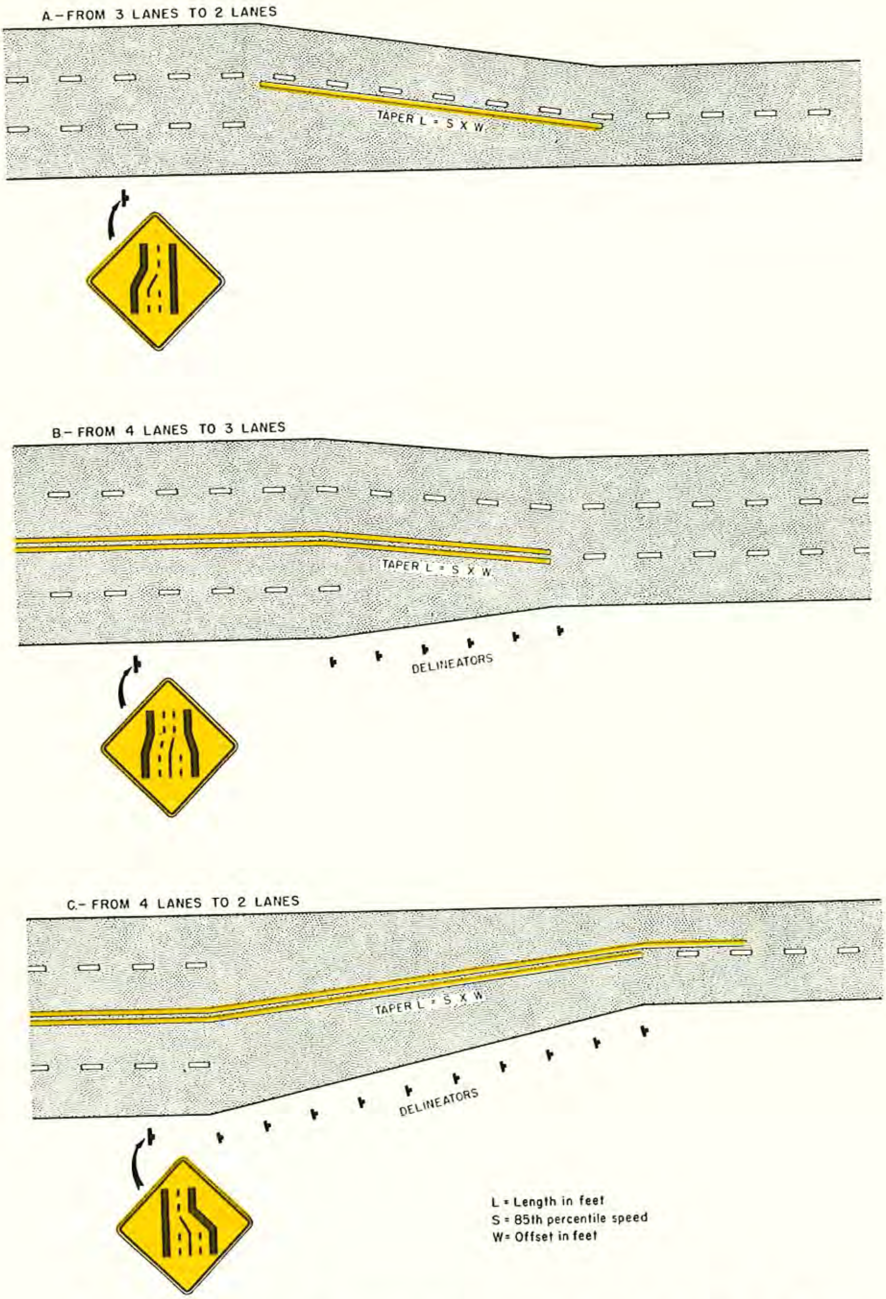

A.-FROM 3 LANES TO 2 LANES
TAPER L = S X W.
B- FROM 4 LANES TO 3 LANES
TAPER L = S X W.
DELINEATORS
C.- FROM 4 LANES TO 2 LANES
TAPER L = S X W
DELINEATORS
L = Length in feet
S = 85th percentile speed
W= Offset in feet

Figure 2–4. *Typical pavement-width transition markings and signs.*

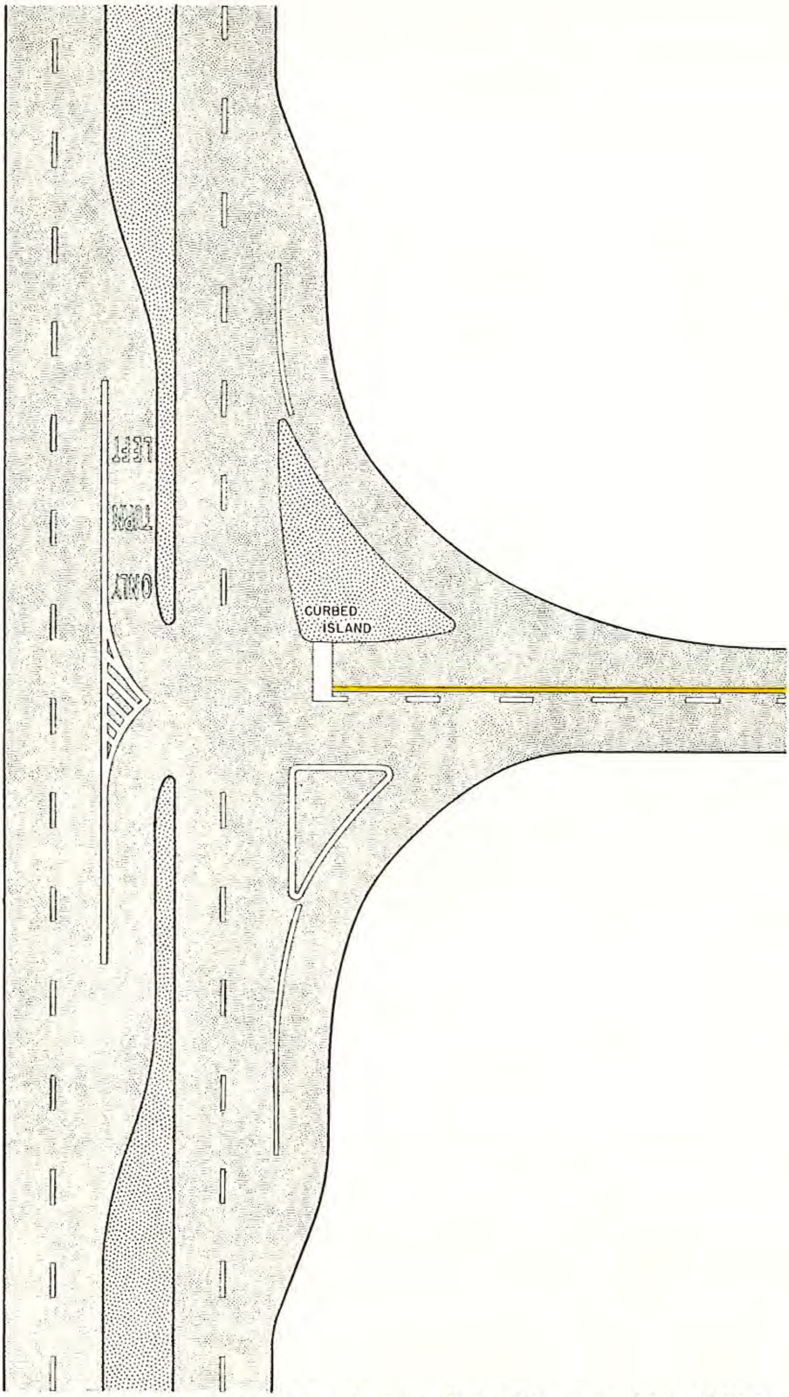

LEFT
TURN
ONLY
CURBED
ISLAND

Figure 2–5. Typical applications of channelizing lines: marking right-turn acceleration and deceleration lanes, forming channelizing islands, and marking left-turn storage and inside acceleration lanes.

The wide solid line may also be used in lieu of the normal-width center line on urban streets to emphasize the center line or to distinguish it at points where solid lane lines are used. On a two-lane two-way road the solid line may be placed on the center line where emphasis is needed and a barrier stripe is too restrictive.

A single solid white line may be used to separate the primary traffic lanes from lanes for special use, such as uphill climbing lanes or transit lanes.

Another use of the channelizing line is in the marking of exit and entrance ramps (sec. 2B–16).

Typical examples of uses of the channelizing line are shown in figures 2–5 to 2–8, and 2–11.

2B–16 Marking of Exit and Entrance Ramps on Expressways

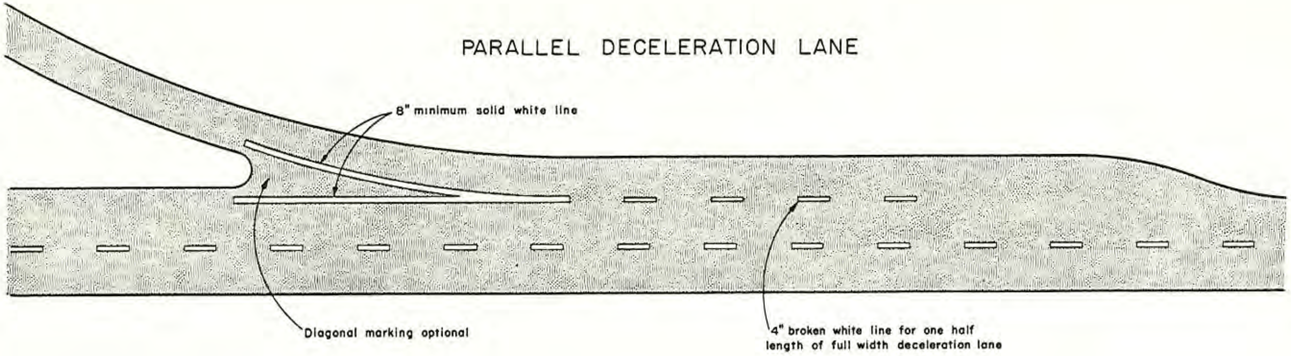
Use of the channelizing lane at exit ramps of expressways provides a neutral area which reduces the possibility of conflict with the curb nose and also directs turn-off traffic at the proper angle for smooth divergence. At entrance ramps the line promotes safe and efficient merging with the through traffic. (See figures 2–6 and 2–7.)

Exit ramp marking.—**A solid white line at least 8 inches in width shall be placed along the sides of the triangular neutral area between the edges of the main roadway and the exit ramp lane at the gore of every exit ramp terminal. With a parallel deceleration lane, a broken white line shall be placed from the apex of the triangular area for a distance of approximately one-half the length of the full width deceleration lane.** Where additional emphasis is desired, diagonal markings may be used within the neutral area.

Entrance ramp marking.—**A solid white line at least 8 inches in width shall be placed along the side of the triangular neutral area adjacent to the ramp lane at the gore of every entrance ramp terminal. With parallel acceleration lanes, a broken white line shall be placed from the apex of the triangular area for a distance of approximately one-half the length of the full width acceleration lane.** With tapered acceleration lanes a similar broken white line may be placed beyond the solid line but not beyond the point where the tapered line meets the outer edge of the near through lane.

> *Interstate.*—The above-described exit and entrance ramp markings are those prescribed for use on the Interstate System.

PARALLEL DECELERATION LANE


8" minimum solid white line
Diagonal marking optional
4" broken white line for one half length of full width deceleration lane

TAPERED DECELERATION LANE

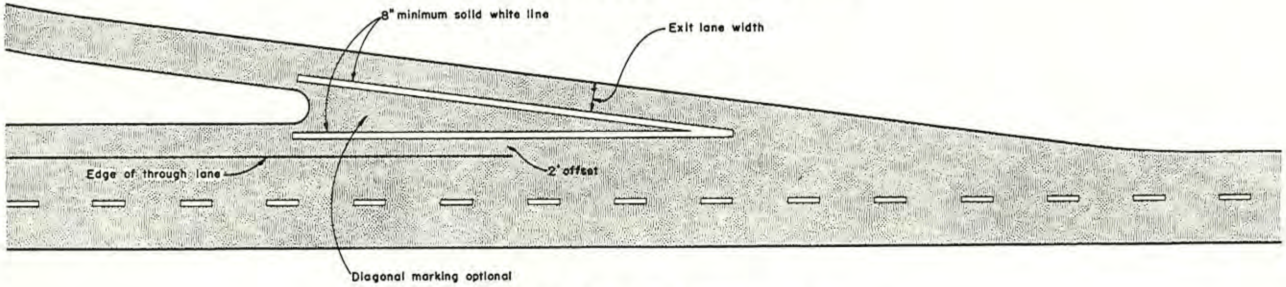
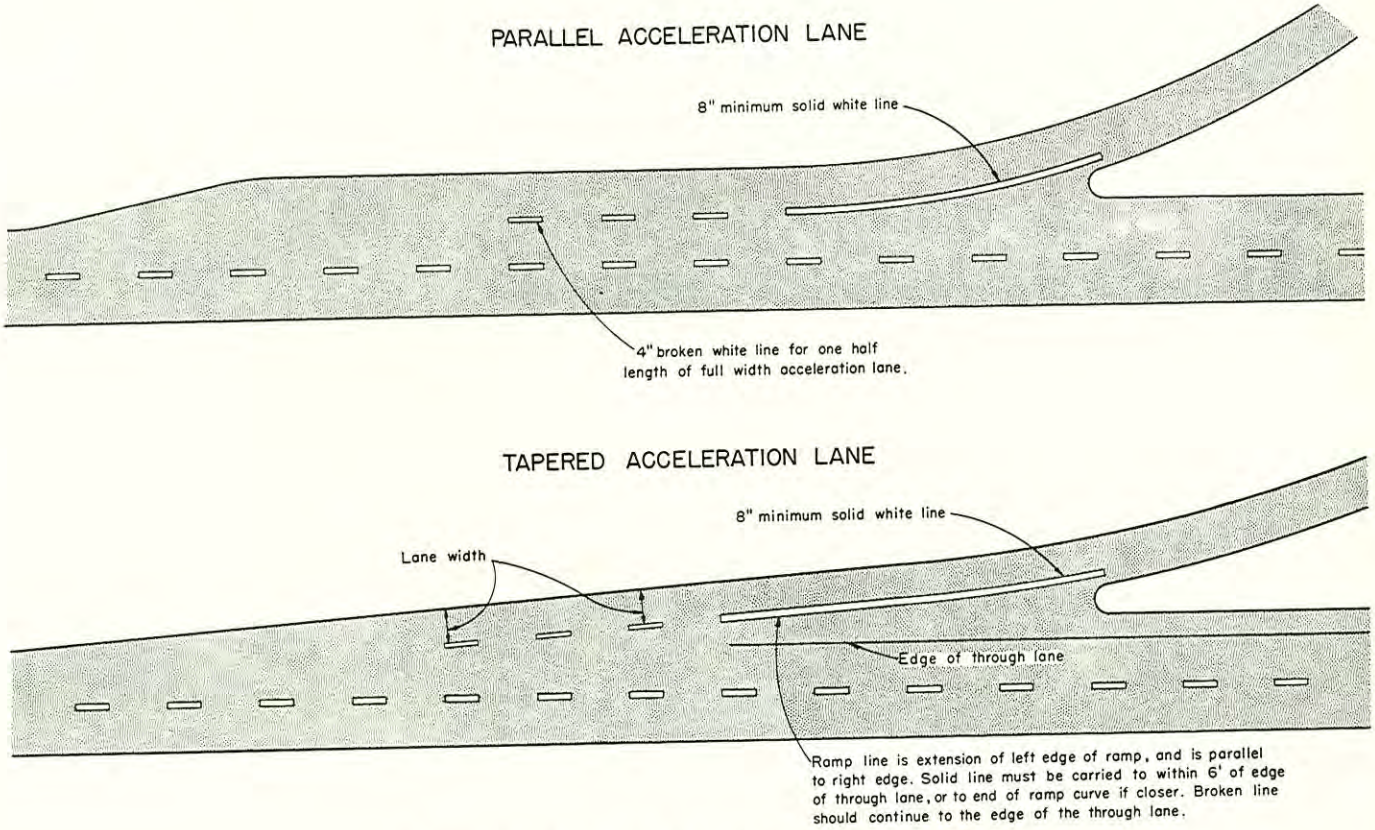

8" minimum solid white line
Exit lane width
Edge of through lane
2' offset
Diagonal marking optional

Figure 2–6. Standard exit ramp markings.



PARALLEL ACCELERATION LANE

8" minimum solid white line

4" broken white line for one half length of full width acceleration lane.

TAPERED ACCELERATION LANE

8" minimum solid white line

Lane width

Edge of through lane

Ramp line is extension of left edge of ramp, and is parallel to right edge. Solid line must be carried to within 6' of edge of through lane, or to end of ramp curve if closer. Broken line should continue to the edge of the through lane.

Figure 2–7. *Standard entrance ramp markings.*

2B–17 Approach to an Obstruction

Pavement markings shall be used to supplement standard signs and to guide traffic on the approach to fixed obstructions within a paved roadway.

Obstructions within the roadway are hazards that should not be permitted to exist if avoidable. Where they cannot reasonable be eliminated, everything possible should be done to prevent vehicles from colliding with them. An obstruction may be so located that all traffic must keep to the right of it, or it may be between two lanes of traffic moving in the same direction. The markings in either case must be designed to deflect traffic away from the obstruction by a diagonal line or lines of unmistakable meaning.

Obstruction approach markings shall be used only to supplement adequate markings on the obstruction itself as prescribed in section 2C–2.

2B–18 Obstruction Approach Markings

Obstruction approach pavement markings shall consist of a diagonal line, or lines, extending from the center or lane line to a point 1 to 2 feet to the right side, or to both sides, of the approach end of the obstruction (fig. 2–8). All lines used in obstruction approach markings shall be not less than 4 nor more than 12 inches wide.

The length of the diagonal markings should be determined by the formula $L=S \times W$ where L equals the length in feet, S the (offpeak) 85-percentile speed in miles per hour, and W the width of the offset in feet. **In no case shall the diagonal line be less than 200 feet in length in rural areas or 100 feet in urban areas.**

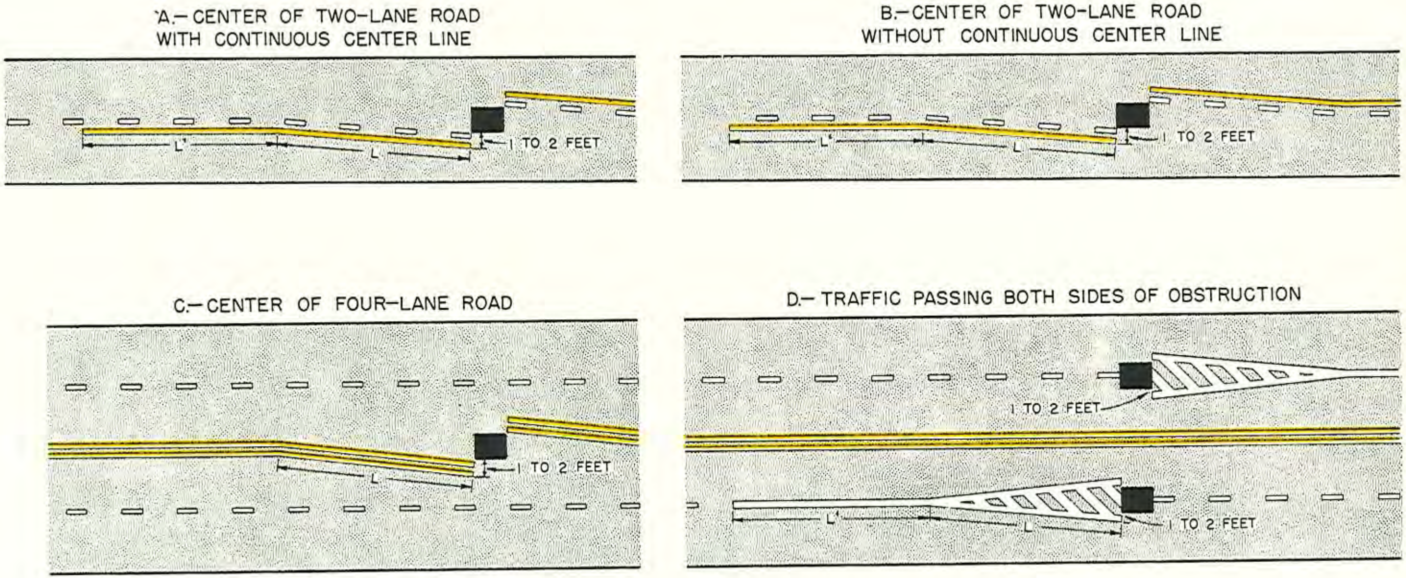
If traffic is required to pass only to the right, the diagonal line shall be marked to the right and shall be of one of the following designs:

1. A normal broken center line flanked by a solid barrier line, as specified for no-passing zones (sec. 2B–8). The barrier line shall extend along the center line in advance of the diagonal line for an additional distance equal to the length of the diagonal line.

2. On roads of four lanes or more a simple continuation of the double center line prescribed for such roads (sec. 2B–2).

In addition, a solid white diagonal line may be extended to the left of the obstruction, to outline the triangular area from which traffic must be excluded for safety.

If traffic may pass either to right or left of the obstruction barrier lines cannot be used. **In this case there shall be two solid white lines diverging from the lane line, one to either side of the**


A.– CENTER OF TWO-LANE ROAD WITH CONTINUOUS CENTER LINE
L'
L
1 TO 2 FEET
B.– CENTER OF TWO-LANE ROAD WITHOUT CONTINUOUS CENTER LINE
L'
L
1 TO 2 FEET
C.– CENTER OF FOUR-LANE ROAD
L
1 TO 2 FEET
D.– TRAFFIC PASSING BOTH SIDES OF OBSTRUCTION
1 TO 2 FEET
L'
L
1 TO 2 FEET

$L' = L$
$L = S \times W$
L = Length in feet
S = 85th percentile speed in miles per hour
W = Width of the obstruction in feet (offset distance)
Minimum length of $L = 100$ feet in urban areas,
200 feet in rural areas

Figure 2–8. Approach markings for obstructions in the roadway.

obstruction for a length determined by the formula $L=S \times W$. In advance of the point of divergence a single solid white line shall be extended in place of the normal broken lane line for a distance equal to the length of the diverging lines.

As an added safeguard it is desirable, especially where traffic is permitted to pass to both right and left of an obstruction, to place broad transverse, diagonal, or longitudinal lines in the triangular area between the guide lines, as shown in figures 2–8 and 2–14.

Similar markings are desirable at channelizing islands not so designed as to divert traffic naturally from them.

2B–19 Turn Markings

Markings to control and guide turning vehicles are sometimes used at intersections. Turn markings have not been satisfactorily standardized, but if used they should be so designed as to indicate the proper course for turning vehicles without being needlessly confusing to through traffic or traffic making other turns. **Such markings shall be white.**

2B–20 Transverse Lines

Because of the low angle at which pavement markings are viewed from an approaching vehicle, it is necessary that all transverse lines be proportionately widened to give visibility equal to that of longitudinal lines, or to avoid apparent distortion where longitudinal and transverse lines are combined in symbols or lettering. This applies particularly to Stop lines, crosswalk markings, railroad-crossing markings, and word and symbol markings.

Particular attention must be given to the maintenance of transverse lines which, because of their position on the pavement, are subject to constant wear by every vehicle that passes.

2B–21 Stop Lines

Stop lines shall be solid white lines, not less than 12 nor more than 24 inches wide. They shall extend across all approach lanes (fig. 2–11).

On urban streets where speeds are not high a width of 12 to 18 inches is usually sufficient.

Stop lines (or Limit lines) should be used in both rural and urban areas where it is important to indicate the point behind which vehicles are required to stop in compliance with a Stop sign, traffic signal, officer's direction, or other legal requirement.

Stop lines, where used, should ordinarily be placed 4 feet in advance of, and parallel to, the nearest crosswalk line. In the absence of a marked crosswalk, the Stop line should be placed at the desired stopping point, in no case more than 30 feet or less than 4 feet from the nearest edge of the intersecting roadway.

If a Stop line is used in conjunction with a Stop sign, it should ordinarily be placed in line with the Stop sign. However, if the sign cannot be located exactly where vehicles are expected to stop, the Stop line should be placed at the stopping point.

The word STOP shall not be placed on the pavement in advance of a Stop line, unless every vehicle is required to stop at all times.

2B–22 Crosswalk Lines

Crosswalk lines, in both rural and urban areas, shall be solid white lines, marking both edges of the crosswalk. They shall be not less than 6 inches wide (fig. 2–10, 11, and 4–6). If no advance Stop line is provided, it may be desirable to increase the width of the crosswalk line on the approach side to as much as 24 inches, particularly where speeds are greater than 35 m.p.h. and in rural areas where crosswalks are unexpected.

Crosswalks shall be marked at all intersections where there is material conflict between vehicular and pedestrian movement. Marked crosswalks should also be provided at other appropriate points where there is substantial pedestrian movement, as at long loading islands, or where pedestrians are permitted to cross between intersections, or where pedestrians could not otherwise recognize the proper place to cross.

To promote acceptance of the crosswalk as a pedestrian safeguard, the limits of the crosswalks must be distinctly indicated, both to pedestrians and to drivers. For this reason, two lines are necessary to define the crosswalk area.

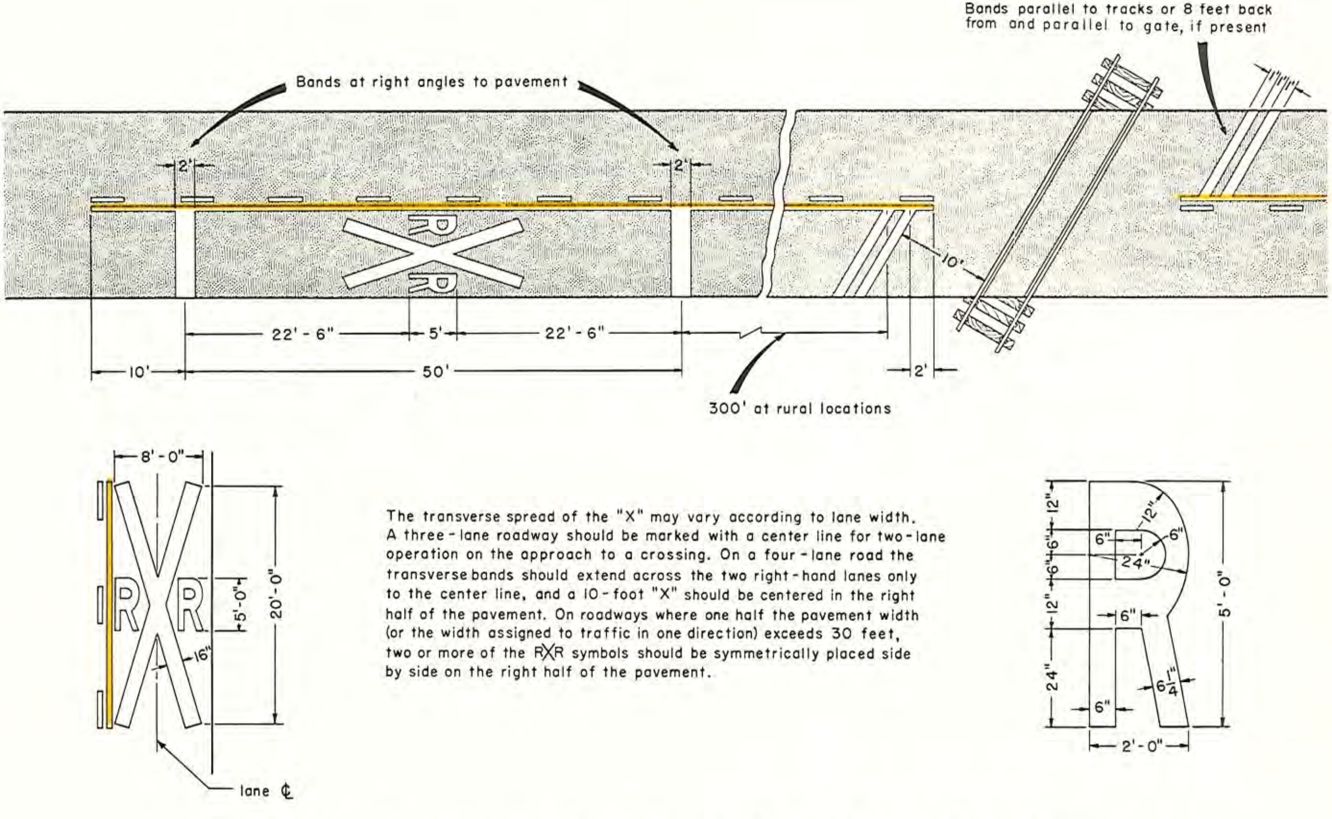
The width of the crosswalk between crosswalk lines is usually determined by the width of the sidewalks so connected. **The width shall in no case be less than 6 feet.**

Crosswalk lines on both sides of the crosswalk should meet the curb to discourage diagonal walking between crosswalks.

2B–23 Approach to Railroad Crossing

Pavement markings consisting of a cross, the letters RR, a no-passing zone marking, and certain transverse lines shall be placed on all paved approaches to railroad crossings, except at minor sidings in urban areas where other protection is afforded. Such markings shall be white except for the no-passing barrier line, which shall be yellow.

The design of railroad crossing pavement markings shall be essentially as illustrated in figure 2–9. The symbol and letters


Bands parallel to tracks or 8 feet back from and parallel to gate, if present
Bands at right angles to pavement
2'
2'
10'
22' - 6"
5'
22' - 6"
10'
50'
2'
300' at rural locations
8'-0"
5'-0"
20'-0"
16"
lane ℄
12"
6"
6"
12"
24"
6"
24"
12"
6"
6"
6¼"
6"
5'-0"
2'-0"

The transverse spread of the "X" may vary according to lane width. A three-lane roadway should be marked with a center line for two-lane operation on the approach to a crossing. On a four-lane road the transverse bands should extend across the two right-hand lanes only to the center line, and a 10-foot "X" should be centered in the right half of the pavement. On roadways where one half the pavement width (or the width assigned to traffic in one direction) exceeds 30 feet, two or more of the R╳R symbols should be symmetrically placed side by side on the right half of the pavement.

Figure 2–9. Standard pavement markings at railroad-highway grade crossings.

are elongated to allow for the low angle at which they are viewed.

While these markings have value as a means of attracting the attention of the driver to the proximity of a railroad grade crossing, because they are distinctively different from all other pavement markings, they are only auxiliary to the standard Railroad Advance Warning sign (sec. 1C–31) and the Crossbuck sign (sec. 1C–32), which must be used in every case, and crossing signals or gates.

2B–24 Parking Space Limits

All lines for parking spaces shall be solid white lines, not less than 4 inches nor more than 6 inches wide.

The marking of parking space limits on urban streets encourages more orderly and efficient use of parking spaces, and tends to prevent encroachment on fire hydrant zones, bus stops, loading zones, approaches to corners, and clearance spaces for islands.

The ends of a parking zone may be indicated on the pavement by lines marked perpendicular to the curb and extending into the roadway the width required by a parked vehicle, usually 8 to 10 feet. As a further refinement a line may be placed parallel to the curb connecting the street ends of these perpendicular lines, indicating the outside boundary of the parking zone.

The zone may be further divided into stalls by the use of similar lines perpendicular to the curb and so spaced that each stall is long enough to accommodate one parked vehicle, usually 22–26 feet. Stalls at the ends of a zone may be 20 feet in length. A short line, parallel to the curb, may be placed at the end of each stall line, in place of the continuous line extending the length of the parking zone. For parking stalls along the left-hand curb of one-way streets, markings may be placed on the curb delineating the ends of the individual stalls. The marking of stalls is especially beneficial where parking meters are used.

Curb markings may also be used to indicate parking prohibitions (sec. 2B–27).

Typical parking space limit markings are shown in figure 2–10.

Angle parking is generally not desirable, though occasionally it may be justified as, for example, on a pavement over 70 feet in width where traffic is light and relatively slow moving. Where angle parking is permitted the marking of lines to indicate the limits of stalls enables all drivers to park at the same angle with a minimum of waste space.

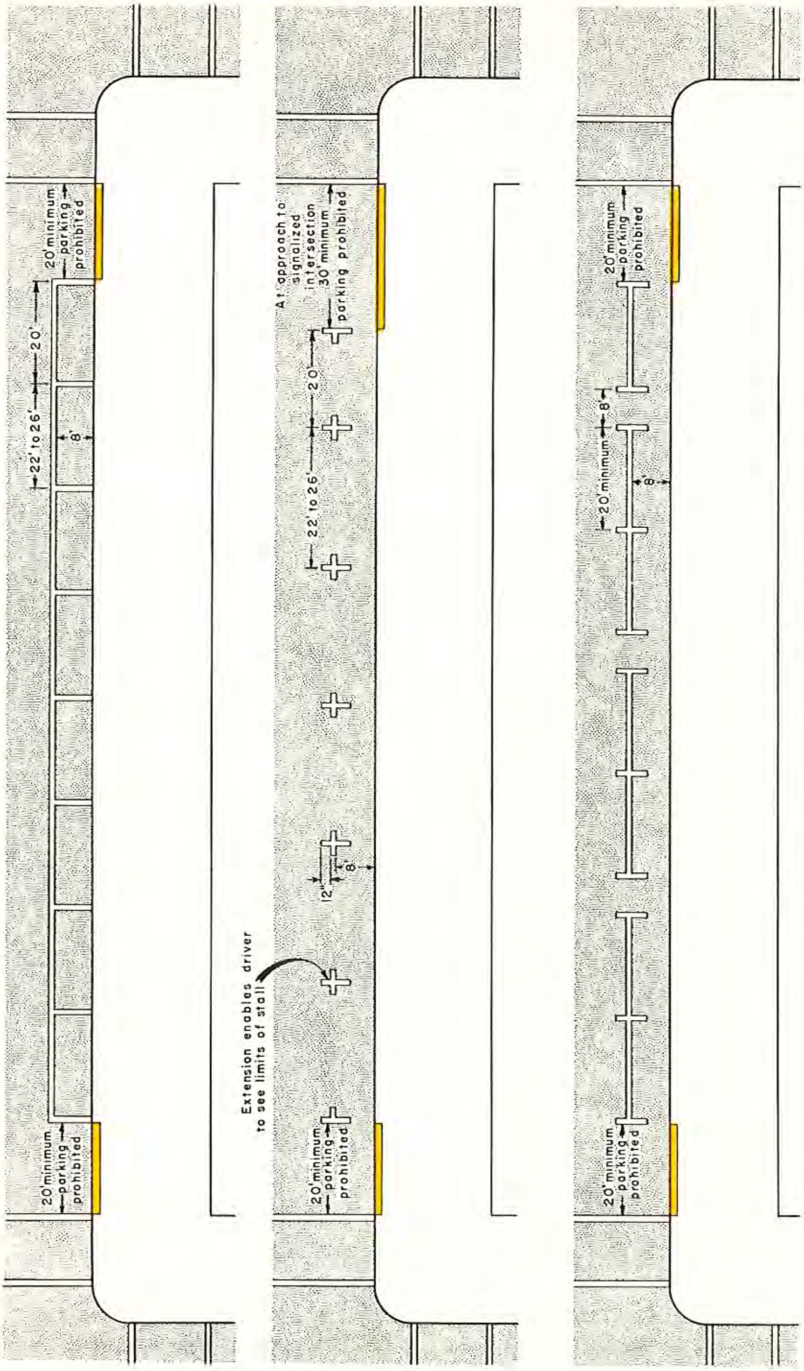

20' minimum parking prohibited
20'
22' to 26'
8'
20' minimum parking prohibited
At approach to signalized intersection 30' minimum parking prohibited
20'
22' to 26'
12"
8'
Extension enables driver to see limits of stall
20' minimum parking prohibited
20' minimum parking prohibited
8'
20' minimum
8'
20' minimum parking prohibited

Figure 2–10. Typical parking-space-limit markings.

2B–25 Word and Symbol Markings

Word and symbol markings on the pavement may be used for the purpose of guiding, warning, or regulating traffic. They should be limited to as few words as possible, never more than three.

Word and symbol markings shall not be used for mandatory messages except in support of standard signs. They shall be white in color.

The letters and symbols should be greatly elongated in the direction of traffic movement because of the low angle at which they are viewed by approaching drivers. Large letters and numerals should be used, 8 feet or more in height; and, if the message consists of more than one word, it should read "up," i.e., the first word should be nearest to the driver. Where speeds are low, somewhat smaller characters may be used. The space between lines should be at least four times the height of the characters. Recommended designs of elongated letters and arrows are shown in figures 2–12 and 2–13.

On high-speed roads, especially where traffic is heavy, messages of more than one line are undesirable and should generally be avoided.

Figures 1–2, 2–5, 2–9, 2–11, 4–11, and 4–17 show uses of word and symbol markings on the pavement.

2B–26 Lane-Use Control Markings

Lane-use control markings should be used on the approach to an intersection to supplement Lane-Use Control signs (sec. 1B–18) indicating the types of movement that are permitted from specific lanes.

The recommended design of word markings and arrows which are applicable are shown in figures 2–12 and 2–13. Figure 2–11 shows typical applications of lane-use control markings.

Additional markings of the same design should also be placed at a sufficient distance in advance of the intersection so that motorists can select the appropriate lane before reaching the end of the line of waiting vehicles.

2B–27 Curb Markings for Parking Restrictions

The curb markings for parking restrictions shall be of a solid yellow color, covering the face and top of the curb.

Curb markings may be used to show where parking is prohibited at all times. They should not be used except on curbs along which parking is legally prohibited, either by general ordinance,

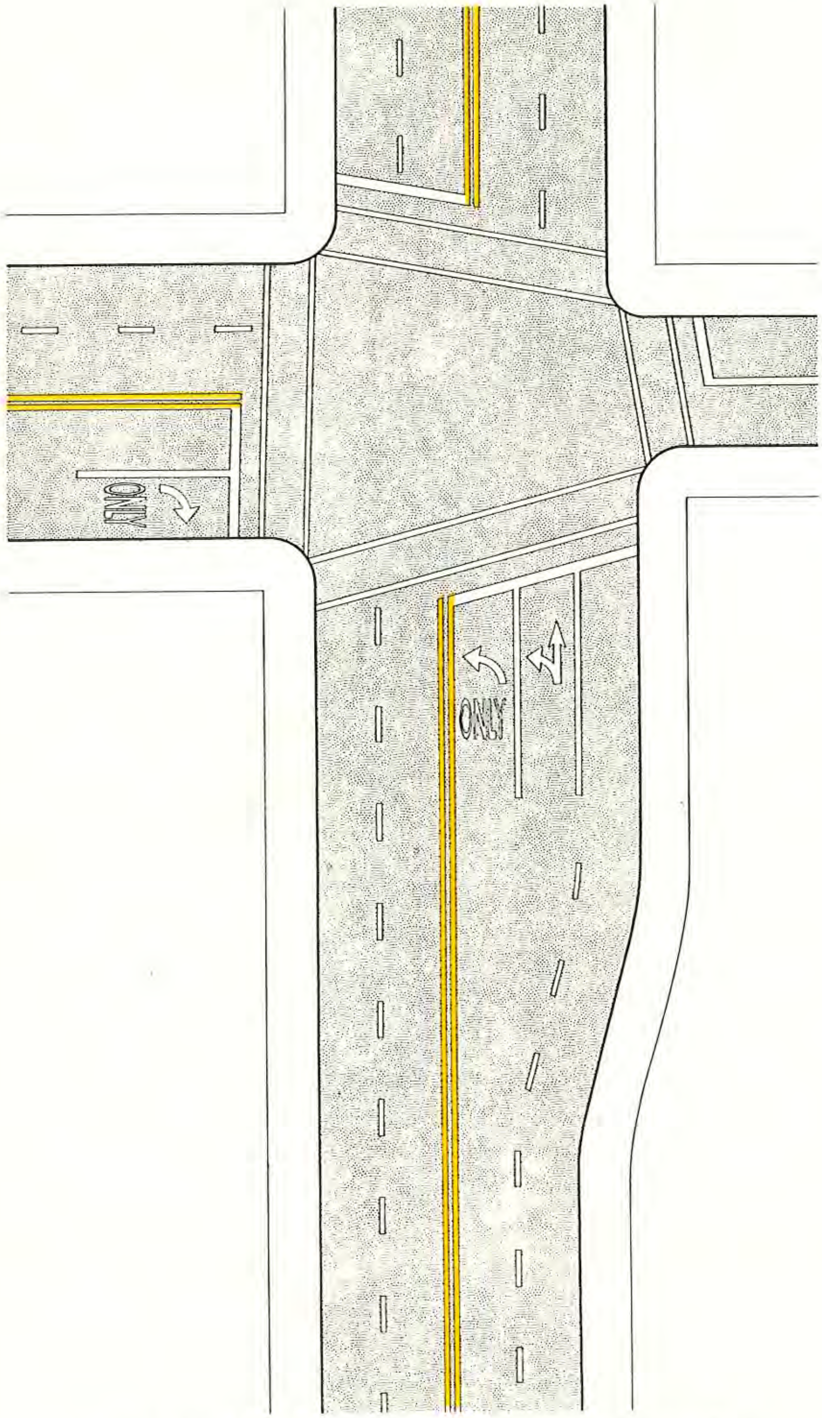


Figure 2–11. Typical applications of lane-use-control markings.

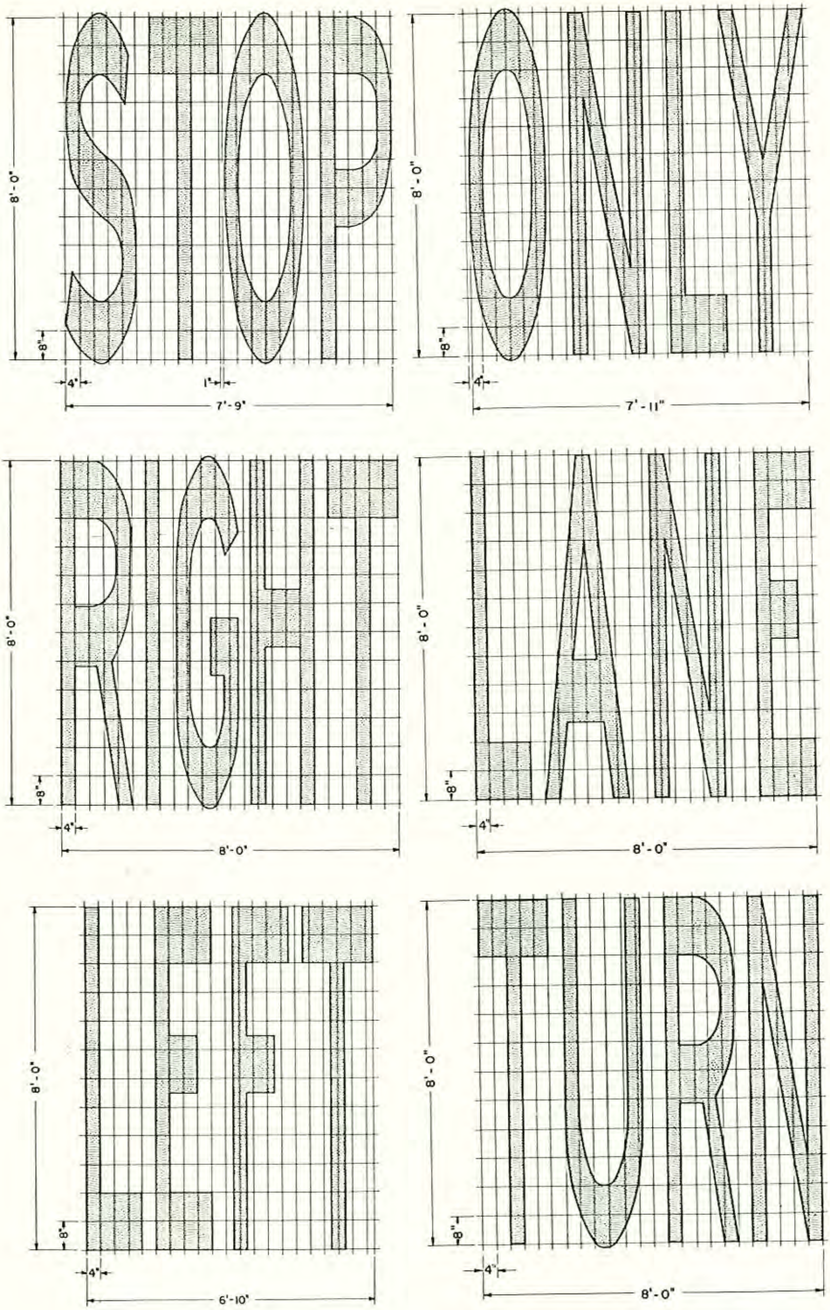

8'-0"
8"
4"
1"
7'-9"
8'-0"
8"
4"
7'-11"
8'-0"
8"
4"
8'-0"
8'-0"
8"
4"
8'-0"
8'-0"
8"
4"
6'-10"
8'-0"
8"
4"
8'-0"

Figure 2–12. **Elongated letters for pavement markings.**

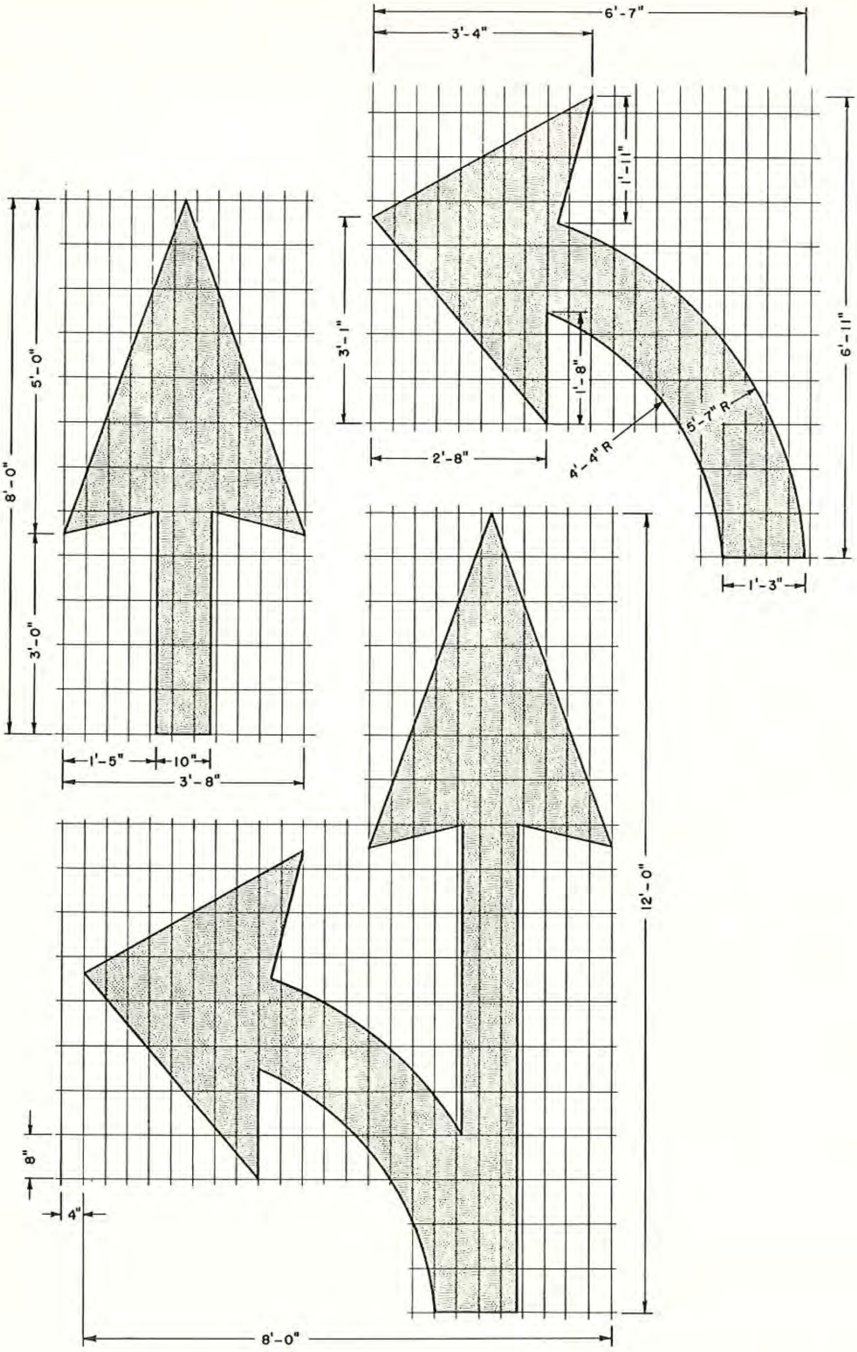

6'-7"
3'-4"
1'-11"
6'-11"
3'-1"
1'-8"
2'-8"
4'-4" R
5'-7" R
1'-3"
8'-0"
5'-0"
3'-0"
1'-5"
10"
3'-8"
12'-0"
8"
4"
8'-0"

Figure 2–13. Elongated arrows for pavement markings.

as at fire hydrants, adjacent to corners, and opposite loading islands, or by the erection of standard no-parking signs.

Experience has shown that the public does not easily understand a color code where several colors are used in curb marking to indicate different types or degrees of parking restrictions. Curb markings are accordingly recommended only to show that parking is prohibited at all times. Other restrictions should be shown by standard parking signs.

C—OBJECT MARKINGS

Section 2C–1 Application of Object Markings

Physical obstructions in or near a roadway that constitute serious hazards to traffic, including installations designed for the control of traffic, shall be adequately marked.

Typical obstructions of this character are bridge supports, monuments, traffic islands, beacon, signal, and overhead sign supports, loading islands, railroad and drawbridge gates, end posts of narrow bridges, underpass piers and abutments, culvert headwalls, poles, trees, and rocks, and structures giving restricted overhead clearance.

Only such immovable obstructions as bridge supports and necessary islands should be permitted to remain within the roadway. Even at the present time, other obstructions are occasionally placed in roadways in the mistaken belief that they will serve as aids to the control of traffic. Such installations include signal pedestals in the center of intersections, sign or signal posts at railroad crossings, and large "mushroom" buttons in active traffic areas. These should invariably be removed for safety. It is often necessary, however, to place barricades and similar devices in or near the roadway in emergencies or at construction or maintenance sites. The proper application and marking of these devices is described in part V (secs. 5C–1 to 8).

Judgment must be exercised in the marking of objects off the roadway, but it may be noted that, even where they are theoretically at a safe distance from the roadway, marking them may prevent serious accidents and facilitate night driving.

In addition to markings, a guardrail should be placed in advance of solid obstructions such as bridge supports, overhead sign supports, and end posts of bridges. The purpose of the guardrail is to deflect vehicles and reduce the severity of impact. Guardrails should be painted white and may be reflectorized.

2C–2 Objects Within the Roadway

Obstructions in the roadway, if not illuminated, shall be marked with reflectorized hazard markers (sec. 2D–2).

For additional emphasis it is advisable also to mark such obstructions, except islands, with reflectorized white paint or not less than five alternating black and reflectorized white stripes. **The stripes shall slope downward at an angle of 45 degrees toward the side of the obstruction on which traffic shall pass. The alternate stripes shall be uniform and not less than 4 inches in width.** They may be as much wider as may be necessary to make a good appearance and to provide sufficient visibility, depending on the size of the object and speed of approaching traffic. Typical markings are illustrated in figure 2–14.

Where the vertical clearance of an overhead structure is less than 1 foot more than the maximum legal height of vehicles, the clearance in feet and inches should be clearly marked on the structure.

A large surface, such as a bridge pier, may require stripes of 12-inch or greater width, depending on its area. The wider stripes are easier and less expensive to apply.

If the obstructing object is such that it does not lend itself readily to the application of painted markings, the striping may be placed on an independent surface attached to or mounted immediately in front of the object.

Appropriate signs (secs. 1B–25, 1C–34) directing traffic to one or both sides of the obstruction should also be used, as applicable.

In addition to the markings on the face of an obstruction in the roadway, warning of approach to the hazard shall be given by line markings on the pavement (sec. 2B–18).

2C–3 Obstructions in the Line of Traffic

Where an obstruction lies in the direct line of traffic, it shall be marked, whether or not it is illuminated. The obstruction and markings thereon should, if possible, be illuminated by a floodlight so constructed that it will adequately light the object but will not throw a glare in the face of traffic approaching from either direction. When floodlighting is not practical, reflective hazard markings (sec. 2D–2) shall be used. A flashing yellow beacon may be used at unusually hazardous obstructions.

2C–4 Object Markings on Curbs

Reflectorized solid yellow should be placed on the curbs of all islands located in the line of traffic flow. It may also be helpful on curbs directly ahead of traffic at T and offset intersections.

2C–5 Objects Adjacent to the Roadway

In some cases objects may not be actually in the roadway, but may be so close to the edge of the roadway as to constitute a definite hazard. These include such encroachments as underpass piers and abutments and culvert headwalls. **Such objects shall be marked with standard clearance markers** (sec. 2D–2) and may be marked in addition with white paint or a diagonal stripe design (sec. 2C–2).

Other adjacent objects that are not likely to be hit unless a vehicle runs well off the roadway, such as guardrails, trees, and rocks may be painted solid white.

D—REFLECTOR MARKERS

Section 2D–1 Application of Reflector Markers

Reflector markers, consisting of single reflecting buttons, clusters of buttons, small panels covered with reflecting coatings, or similar devices, are widely used in marking obstructions and other hazards, or, in series, to indicate alinement of the road. In the latter application they are known as Delineators. Although, like signs, such reflecting units are mounted on posts and convey a warning to the driver, they are much more closely related to obstruction markings or guidelines, and for the purposes of this manual are treated as such.

2D–2 Hazard Markers

Reflector markers may be mounted on or immediately in front of obstructions, or at sharp changes in alinement, to indicate the presence of hazards. Hazard markers should be of such design and should be so placed as to be clearly visible to approaching drivers under ordinary atmospheric conditions from a distance of 1,000 feet when illuminated by the upper beam of standard automobile headlamps.

They should be mounted at a height of approximately 4 feet above the pavement, except when they are applied directly to a hazardous object which by its nature requires higher or lower mounting, such as a low culvert headwall.

The following system covering the use of reflectorized hazard markers shall be used:

1. For obstructions located within the roadway, the hazard marker shall consist of (a) A horizontal strip containing three 3-inch yellow reflectors arranged horizontally or an equivalent strip of yellow reflective material; or (b) Where greater emphasis is needed, in the head-on position, nine 3-inch yellow re-

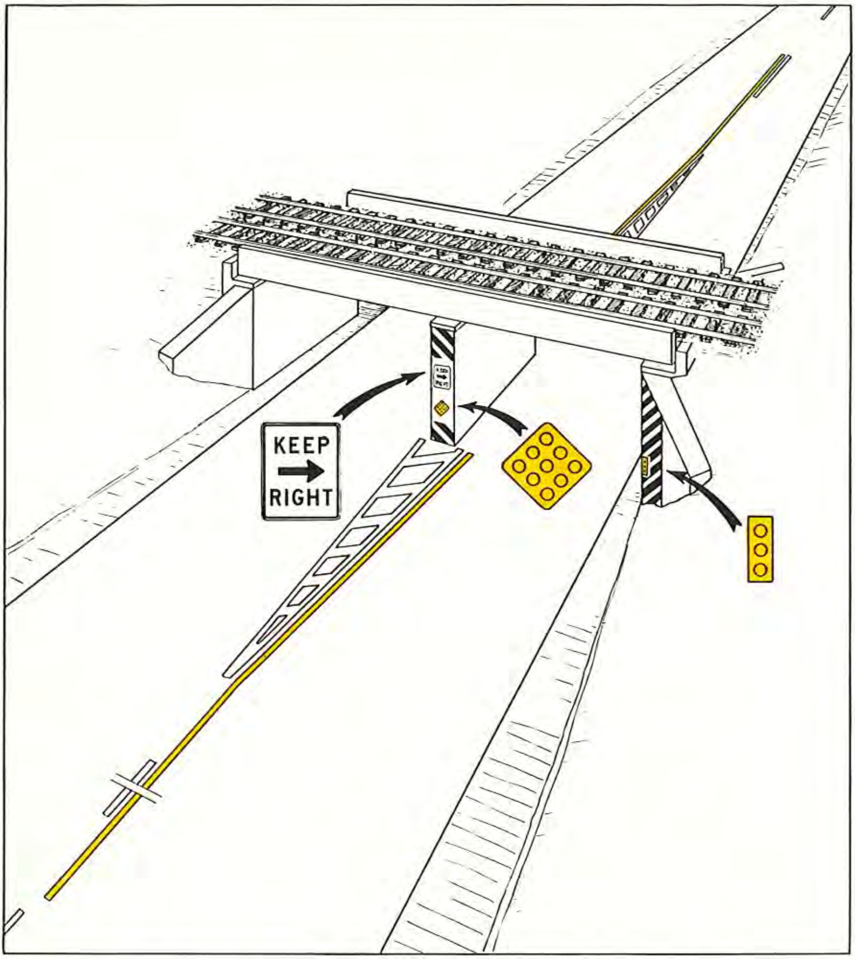


Figure 2–14. Typical markings for obstructions in and adjacent to the roadway.

flectors arranged in a diamond pattern or an equivalent diamond of yellow reflective material.

The horizontal reflector is generally applicable to channelizing islands, etc., whereas the larger reflective units are more applicable to piers or other more hazardous obstructions or at dead-end locations.

2. To delineate bridge ends, underpass abutments, and all other obstructions closely adjacent to the edges of the roadway, the hazard marker, more specifically designated in this application as a clearance marker, shall consist of (a) Three 3-inch yellow plastic reflectors arranged vertically, or an equivalent strip of yellow reflective material; or (b) A vertical rectangle, approximately 1 foot

by 3 feet in size, having alternating black and reflectorized white stripes sloping down at an angle of 45 degrees toward the side of the obstruction on which traffic shall pass. The minimum stripe width shall be 2 inches.

The inside edge of the clearance marker shall be in line with the inner edge of the obstruction.

Better appearance of the striped vertical marker can be achieved if the black stripes are made slightly wider than the white stripes.

Standard signs (secs. 1B–25, 1C–9) should also be used, where applicable.

Typical applications of hazard markers are shown in figures 1–1, 2–14, and 4–11.

2D–3 Delineators

Road-delineation markers are effective aids for night driving. Delineators are to be considered as guide markings rather than warning devices. They may be used on long continuous sections of highway or through short stretches where there are changes in horizontal alinement, particularly where the alinement might be confusing, or at pavement-width transitions. An important advantage of delineators, in certain areas, is that they remain visible when there is snow on the ground.

2D–4 Delineator Design and Application

Delineators shall consist of reflector units capable of reflecting light clearly visible under normal atmospheric conditions from a distance of 1,000 feet when illuminated by the upper beam of standard automobile headlamps.

Glass or plastic prismatic reflective elements or plastic elements with reflective sheeting sealed therein used for delineators shall be approximately 3 inches in diameter or may be another geometric shape so long as the area of the unit will contain an inscribed circle having a diameter of approximately 3 inches. For multiple application as described below, elongated reflective units of appropriate size may be used in place of the two or three circular units.

If exposed reflective coating is used, the single unit should be approximately 3 inches by 8 inches in size, mounted vertically. Multiple delineators of exposed reflective coating should consist of 5-inch by 5-inch squares, mounted as diamonds, in a vertical arrangement.

> *Interstate.*—Design specifications for delineators on the Interstate System are the same as those prescribed above.

When used on through roadways delineators shall be single white reflector units. They shall be placed on the right-hand side of two-way roadways, and on the right or on both sides of one-way roadways. They may be placed on the left of two-way roadways only at hazardous right-hand curves. At sharp curves delineators are more effective if placed on the outside of the curve.

Where delineators are used on the left at a hazardous right-hand curve on a two-way roadway, they may be bi-directional, i.e., delineators with two faces, visible from opposite directions, or two delineators mounted back to back. **All other delineators shall be mono-directional.**

At pavement-width transitions, a delineator installation may be used to indicate the narrowing of the pavement where an outside lane merges into an adjacent lane (fig. 2–4). The delineators should be on the side of the roadway adjacent to the lanes affected and should be so spaced as clearly to show the narrowing. Where the narrowing occurs on the side of the roadway that does not carry traffic in the direction of convergence (as on the left-hand side of a two-way roadway) there is no need for this installation. Similarly, such an installation is unnecessary for traffic moving in the direction of the wider pavement. On a highway with continuous delineation, the normal delineator spacing should be carried through the transition except where a closer spacing is warranted (sec. 2D–5).

Delineators should be used at vertical curves where there is an abrupt change in grade or where there is a change in both vertical and horizontal alinement.

The following system of delineation is prescribed for use where delineation is desired on expressway-type facilities:

Single white reflector units shall mark the through roadways, and double or vertically elongated yellow reflectors shall mark the interchange ramps and the speed-change lanes. A triple or correspondingly elongated yellow delineator shall be placed at the end of an acceleration lane.

Delineators shall be placed continuously along the right side or on both sides of the through roadways, and on the outside or both side of interchange-ramp connections. Delineators need not be used where fixed-source lighting is installed and in operation. At speed-change lanes, the delineators shall be installed on the right for right-hand connections, and on the left for left-hand connections.

> *Interstate.*—Standards for delineation on the Interstate System are consistent with the above except that (a) delineators shall be placed only on the right side of

through roadways, (b) delineators shall not be placed on those sections between interchanges where fixed-source lighting is installed and in operation, and (c) delineation is to be installed on all roadways at all interchanges whether or not the interchanges are lighted.

To indicate clearly the alinement where delineation on one side of the roadway ends and delineation on the other side appears, as at interchange ramps curving to the right, the delineators should be overlapped so that for a short distance the driver will be between two rows of delineators.

2D–5 Delineator Placement and Spacing

Delineators shall be mounted on suitable supports at a height such that the top of the reflecting head is 4 feet above the near pavement or roadway edge. They shall in no case be more than 12 feet nor less than 2 feet outside the roadway or pavement edge. On roadways with shoulders, delineators, if used, shall be installed 2 feet beyond the outer shoulder edge. Along curbed sections of roadway, delineators, if used, shall be placed not less than 2 feet nor more than 5 feet from the curb face.

Interstate.—On the Interstate System metal posts are prescribed for delineator mounting. Delineators shall be placed 2 feet beyond the shoulder edge or 2 feet outside the face of an unmountable curb.

Normally, delineators should be spaced 200 to 400 feet apart. Where normal spacing is interrupted by driveways, crossroads, etc., and where, under the normal spacing, a delineator would fall within such an area, that delineator may be moved in either direction a distance not exceeding one quarter of the normal spacing. If such delineator still falls within that area, it should be eliminated.

On the approaches to and throughout horizontal curves, the spacing should be such as to make several delineators always visible along the curve, ahead of the driver. Table 1 shows the recommended spacing for delineators at horizontal curves.

Where delineators are used on expressway-type facilities, delineator spacing shall be 200 feet along the through roadways. The yellow delineators shall be spaced at 100 feet at acceleration and deceleration lanes and along relatively straight portions of the interchange ramps. Delineators on the outside of interchange ramp curves shall be placed at the appropriate spacing as set forth in table 1.

Interstate.—Standards for the spacing of delineators on the Interstate System are the same as those for expressway-type facilities described above.

Table 1.—Spacing[1] for highway delineators on horizontal curves

Degree of curve	Radius in feet	Spacing on curve	Spacing in advance and beyond curve		
			First space	Second space	Third space
		Feet	*Feet*	*Feet*	*Feet*
	10,000	200	200	200	200
1		152	200	200	200
	5,000	141	200	200	200
	3,000	109	196	200	200
2		106	191	200	200
	2,500	99	178	200	200
	2,000	88	158	200	200
3		86	155	200	200
	1,800	84	151	200	200
	1,600	78	140	200	200
4		74	133	200	200
	1,400	74	133	200	200
	1,200	68	122	200	200
5		66	119	198	200
	1,000	62	112	186	200
	900	58	104	174	200
7		55	99	165	200
	800	55	99	165	200
	700	51	92	153	200
9		48	86	144	200
	600	47	85	141	200
	500	42	76	126	200
12		41	74	123	200
	400	37	67	111	200
15		36	65	108	200
	350	35	63	105	200
18		33	59	99	198
	300	32	58	96	192
21		30	54	90	180
	250	28	50	84	168
25		28	50	84	168
	200	24	43	72	144
30		24	43	72	144
	150	20	36	60	120
40		19	34	57	114
	100	14	25	42	84

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[1] The spacing S on the curve is found from the formula $S = 2\sqrt{R - 50}$, where R is the radius of the curve in feet. The spacing to the first delineator in advance of and beyond the curve is 1.8 S, to the next delineator $3S$, and to the next $6S$, but not to exceed 200 feet. Minimum spacing is 10 feet.

Part III

SIGNALS

A—INTRODUCTION

Section 3A–1 Definitions

Highway traffic signals include all power-operated traffic control devices, except flashers, signs, and markings, by which traffic is warned or is directed to take some specific action. A glossary of traffic signal terms will be found in appendix A.

3A–2 Value of Signals

The traffic signal is a valuable device for the control and safe facilitation of vehicle and pedestrian traffic. Because of its predetermined or traffic-induced assignment of right-of-way to the various movements necessary at intersections and at other street and highway locations, the traffic signal exerts a profound influence on traffic flow. In most cases a signal installation will operate quite definitely to either the advantage or disadvantage of the vehicles and persons controlled. Consequently it is of the utmost importance that the selection and use of such an important control device be preceded by thorough study of roadway and traffic conditions by an experienced engineer. Equally urgent is the need for checking the efficiency of a traffic signal once in operation to ascertain the degree to which the type of installation and the timing program meet the requirements of traffic, and to permit intelligent operating adjustments to be made in the controls. Checkbacks are of value not only to the particular installation concerned but in the selection of proper equipment and operating plans for future installations as well.

Highway traffic signals, properly located and operated, usually have one or more of the following advantages:

1. They provide for orderly movement of traffic. Where proper physical layouts and control measures are used they can increase the traffic-handling capacity of the intersection.
2. They reduce the frequency of certain types of accidents.
3. Under conditions of favorable spacing, they can be coordinated to provide for continuous or nearly continuous movement of traffic at a definite speed along a given route.
4. They can be used to interrupt heavy traffic at intervals to permit other traffic, pedestrian or vehicular, to cross.

5. They represent a considerable economy, as compared with manual control, at intersections where the need for some definite means of assigning right-of-way first to one movement and then to another is indicated by the volumes of vehicular and pedestrian traffic, or by the occurrence of accidents.

There is a belief among many laymen and some engineers that traffic signals are the answer to all traffic problems at intersections. This has led to their installation at a large number of locations where no legitimate factual warrant exists. The erroneous attitudes that sometimes lead to unjustified installations of traffic control signals should be resisted.

To fill emergency needs there has been some use of portable types of traffic control signals. These devices have limited value and are difficult to standardize, particularly as to application and location. Drivers become accustomed to the presence or absence of standard traffic signal controls, and the introduction of a portable signal, even for a temporary period, may create hazard. The portable traffic signal is therefore not recognized in this Manual as a standard traffic control device.

Many standard traffic signal installations, even though warranted by traffic and roadway conditions, have been ill-designed, ineffectively placed, improperly operated, or poorly maintained. The typical consequences are excessive delay, disobedience to signal indications, use of less adequate alternate routes to avoid signals, and, often, increased accident frequency. Similar difficulties are found when signals are installed under conditions that do not satisfy the minimum warrants set forth in this Manual.

A careful analysis of capacity characteristics and other conditions at a large number of traffic signal installations, coupled with the judgment of engineers with long experience in the signal field, has provided a series of minimum warrants that define the conditions under which traffic signal installations may be justified. These warrants are presented in this Manual for several traffic signal classifications (secs. 3D–3 to 9; 3E–3, 4; 3F–2; 3G–3, 11, 16; 3H–3).

Separate warrants are given for rural and urban conditions in recognition of differences in the nature and environment of traffic in these two general classes. Drivers in rural areas are conditioned to relatively light traffic, and rural intersections with only moderately heavy traffic volumes have greater potentials in terms of congestion and hazard than do similar intersections within a city area where heavier volumes predominate.

3A–3 Standardization

Because of the increasing range of traffic circulation, it is of primary importance that there be national standardization of those features of traffic signals that affect public participation in traffic movement. Design, application, location, and operation lend themselves to a certain degree of standardization, and standards for such features are presented herein.

A driver or pedestrian must first see signals and then react to their indications. Location and sequence of operation are basic requirements. Signals should be placed where a driver (or pedestrian) cannot miss seeing them. Standard signal indications and sequences should be used universally so that a signal message can be recognized and heeded at a glance.

3A–4 Legal Authority

Traffic control signals should be installed and operated on public highways only by legally delegated or constituted public authority. The erection of signs or other devices that hide from view or interfere with the effectiveness of any traffic signal should be prohibited. It is imperative that traffic signal indications be strictly observed and enforced. Suitable legislative models covering these points are presented in the Uniform Vehicle Code (secs. 11–201 to 206) and in the Model Traffic Ordinance (secs. 4–1 to 9). The Code and the Ordinance direct the State highway commission and the city traffic engineer, or similar public officials or bodies, to place and maintain a uniform system of traffic control devices correlated with and, so far as possible, conforming to the system currently approved by the American Association of State Highway Officials. When this broad control is properly exercised, the full value of standardization in traffic signal design and installation can be realized.

3A–5 Classification

In the classification of traffic signals that follows, the distinction is made on the basis of operating function and not the traffic signal unit itself. It is common practice to use the term "signal" to describe the complete installation, and that practice will be followed in this manual.

Highway traffic signals are thus classified herein as follows:

1. Traffic control signals (Stop-and-Go):
   - (a) Pretimed signals (secs. 3D–1 to 25).
   - (b) Traffic-actuated signals (secs. 3E–1 to 29):
     - (1) Full traffic-actuated signals.
     - (2) Semi-traffic-actuated signals.
     - (3) Traffic-adjusted signals.
2. Pedestrian signals (secs. 3F–1 to 7).

3. Special traffic signals:
   - (a) Flashing beacons (secs. 3G–2 to 7).
   - (b) Lane-direction-control signals (secs. 3G–8 to 14).
   - (c) Traffic signals at drawbridges (secs. 3G–15 to 19).
4. Train-approach signals and gates (secs. 3H–1 to 10).

B—FEATURES COMMON TO PRETIMED AND TRAFFIC-ACTUATED SIGNALS

Section 3B–1 General Aspects of Signals

The features of traffic control signals in which vehicle operators and pedestrians are interested, namely, the location, design, indications, and legal significance of the signals themselves, are identical in pretimed and traffic-actuated signals, the difference between the two being in the mechanisms by which they are operated. Standardization in those design factors that affect the traffic to be controlled is especially important. The sections immediately following contain all standards and requirements of this nature that are equally applicable to the types of signals named. Standards applicable to but one type, including design features and methods of operation, are presented in subsequent subdivisions.

3B–2 Design for Future Needs

Traffic control equipment should always be purchased with the future in mind. Flexibility that may not be considered immediately necessary will often be found desirable and economical within the life of the equipment.

Equipment that will give long effective life will almost always prove an economy even if the first cost is moderately higher than that of equipment of inferior quality.

3B–3 Number of Lenses per Signal Face

Each vehicular signal face shall have at least three lenses—red, yellow, and green—except where a green arrow lens is used alone to indicate continuous movement, or where signals are used as described in section 3B–22. It may have additional indications as listed herein.

The yellow indication serves the following important traffic control functions that cannot satisfactorily be served by a signal face having only red and green indications:

1. It acts as a transitional indication at the end of the green interval and warns approaching traffic of a pending change in the signal indication.
2. It acts as a clearance interval for traffic within an intersec-

tion or other signalized area as well as for those vehicles approaching so closely that to stop would be hazardous.

3. Flashing yellow is important as a caution signal when the signal is not being operated as a stop-and-go device.

In no case, however, should a traffic signal flash yellow for all traffic entering the intersection. Flashing operation should indicate yellow for the major street and red for all other legs of the intersection, or flashing red for all directions.

Green arrow indications shall be shown at intersections where signals for individual turning movements are provided. These include: (1) Straight-through arrow; (2) left-turn arrow; and (3) right-turn arrow.

Signals for the control of pedestrians may also be required (sec. 3F–2).

3B–4 Color and Position of Lenses

Lenses in a traffic signal face should preferably be arranged in a vertical line. **The red shall be at the top, the yellow immediately below, and the green at the bottom. Where a horizontal mounting is used, the red shall be at the left, the yellow next, and the green at the right.**

Green arrow lenses should normally be located as near as practicable to the movements they control, but **when more than one arrow is placed in the same vertical line, the straight-through arrow shall be below the circular green, if any, the left-turn arrow next, and the right-turn arrow at the bottom. With a horizontal mounting the left-turn arrow shall be to the immediate right of the yellow, the circular green, if used, shall be next, followed by the straight-through and right-turn arrows, respectively.**

Arrows as enumerated above may be placed at angles other than horizontal or vertical to indicate movement into streets which leave the intersection at various angles (sec. 3B–6).

Signals for control of pedestrians shall be adjustable separately from vehicular signal indications and assembled as specified in section 3F–6, and shall be rectangular in shape as specified in section 3F–4. The top indication shall be DONT WALK and the bottom indication shall be WALK.

The colors red, yellow, and green shall conform to the latest standards for adjustable-face traffic control signal heads of the Institute of Traffic Engineers (approved as an American Standard by the American Standards Association), in Institute of Traffic Engineers Technical Report No. 1.[11]

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[11] *Adjustable Face Traffic Control Signal Head Standards,* Technical Report No. 1. Revised 1958, Institute of Traffic Engineers, 2029 K Street, N.W., Washington 6, D.C.

3B–5 Meaning and Application of Color and Arrow Indications

Color and arrow indications in traffic control signals should have the meaning ascribed to them in the Uniform Vehicle Code and no other meanings. In no case, however, should a driver be permitted to enter or proceed through an intersection without due regard for the safety of other persons within the intersection regardless of signal indications.

Satisfactory results from traffic signal operation require a uniform understanding of their color indications. Those herein set forth are in general accord with the Uniform Vehicle Code (secs. 11–202 to 204). **Combinations of signal colors (green with yellow, yellow with red, or green with red) shall not be displayed simultaneously except where green turn arrows are shown together with steady yellow or steady red under those conditions described below.**

This section applies primarily to traffic control signals at intersections, but appropriate interpretation is to be made for use of signals elsewhere.

The intended meanings of the signal indications are as follows:

Circular green (alone):

1. Vehicular traffic facing the signal may proceed straight through or turn right or left unless a sign, reflectorized or preferably illuminated, at such place prohibits either such turn. However, vehicular traffic, including vehicles turning right or left, shall yield the right-of-way to other vehicles and to pedestrians lawfully within the intersection or an adjacent crosswalk at the time such signal is exhibited.
2. Pedestrians facing such signal may proceed across the roadway within any marked or unmarked crosswalk unless directed otherwise by a pedestrian signal.

Steady yellow:

1. Vehicular traffic facing the signal is thereby warned that the red indication will be exhibited immediately thereafter, or that the related green movement is being terminated.
2. Unless otherwise directed by a pedestrian signal, pedestrians facing such signal are thereby advised that there is insufficient time to cross the roadway.

The yellow signal shall not be shown simultaneously with the green or red indication except in the case of an arrow indication which is to allow a particular movement to continue when others in that direction are being stopped.

The yellow lens is required in standard signal apparatus for the reasons indicated in section 3B–3. Confusion has frequently arisen from the misuse of this lens. When the length of the yellow vehicle-clearance interval is correct, and the standard meaning above described is generally observed, necessary functions of warning and clearing the intersection are performed by this interval.

The configuration or dimensions of an intersection, or some physical condition such as high approach speeds, steep hills, or heavy truck traffic, may require a longer than normal clearance interval. In such cases the standard length of the steady yellow interval should be used in the first part of the clearance interval, followed by all-red indications during the second part of the clearance interval.

No circular green or green arrow indication or flashing yellow "caution" indication shall be terminated and immediately followed by a steady red or flashing red indication without the display of the steady yellow clearance interval; however, transition may be made directly from circular green or green arrow indication to flashing yellow indication. **The steady yellow indication shall not be used in any transition from steady red or flashing red indication to circular green, green arrow, or flashing yellow indication.**

Steady red (alone):

1. Vehicular traffic facing the signal shall stop before entering the crosswalk on the near side of the intersection or, if none, then before entering the intersection, and shall remain standing until the green indication is shown.
2. No pedestrian facing such signal shall enter the roadway unless he can do so safely and without interfering with any vehicular traffic, or unless a separate WALK indication is shown.

Green straight-through arrow (alone):

1. Vehicular traffic facing the signal may proceed straight through, but shall not turn right or left. Such vehicular traffic shall yield the right-of-way to other vehicles and to pedestrians legally within the intersection at the time such signal is exhibited.
2. Pedestrians facing the signal may proceed across the roadway within the appropriate marked or unmarked crosswalk unless directed otherwise by a pedestrian signal.

Green turn arrow (alone or with circular green, with steady yellow, with steady red, or with green straight-through arrow):

1. Vehicular traffic facing the signal shall comply with the meaning of the circular green, steady yellow, steady red, or green straight-through arrow indication as if it were shown alone, except that such vehicular traffic may cautiously enter the intersection to make the movement indicated by the green turn arrow. Vehicular traffic shall yield the right-of-way to pedestrians law-

fully within a crosswalk and to other traffic lawfully using the intersection.

2. Pedestrians facing such signal shall comply with the meaning of the circular green, steady yellow, steady red, or straight-through arrow indication as if it were shown alone, unless directed otherwise by a pedestrian indication.

Permitting vehicle operators to make right or left turns during the showing of the red signal without a modifying arrow or sign is not recommended. If turn arrows are shown when through movement is stopped, they should always be illuminated in conjunction with the red signal they modify. Shown alone (except at T intersections where through movement is impossible or over a separate turning lane where continuous movement can be accommodated), they create doubt as to whether further movements are forbidden during the indicated interval. Furthermore, drivers approaching an arrow indication may mistake it for the circular green indication.

The utility of arrow indications depends considerably upon there being a lane available for the movement indicated. Such lanes should be clearly marked at all times.

A circular green indication shall be given only when it is intended to permit traffic in each lane approaching the signal to proceed in any direction which is lawful and practical for traffic in those lanes. This is not intended to prevent prohibition of turns, at all times or during certain periods of the day, by the erection of signs. **When it is intended to permit traffic on a certain lane to make a certain turn or turns and prohibit it from proceeding straight through, the regular circular red lens facing that traffic shall be illuminated together with a green arrow for each permitted turn. Whenever it is intended to permit traffic on a certain thoroughfare or in a certain lane to proceed straight through and prohibit it from making a certain turn or turns, a green arrow for each permitted movement shall be illuminated, and the red lens facing that traffic shall not be illuminated.**

Except as noted below, each green arrow indication shall be followed by a steady yellow clearance interval to allow the traffic controlled by the arrow to clear the intersection. The yellow indication should be shown following the circular green indication, but should not be displayed in any signal face following a green turn arrow if the related turning movement is permitted to continue by a following or continuing display of a circular green indication in the same signal face.

In those cases where a turning movement is to be cut off while the straight-through movement continues, a separate signal face shall be provided to control the turning movement (fig. 3–3). It

shall be equipped with circular red and yellow lenses and a green turn arrow lens. When the turn is to be cut off, a yellow clearance interval shall be shown, followed by a steady red indication. The purpose of such a signal face should be made clear by its location and by a sign located close to the signal and having an appropriate message, such as LEFT TURN SIGNAL or RIGHT TURN SIGNAL.

Flashing red (Stop signal):

When a red lens is illuminated by intermittent flashes (50–60 per minute), drivers of vehicles shall stop before entering the nearest crosswalk at an intersection or at a Stop line when marked, and the right to proceed shall be subject to the rules applicable after making a stop at a Stop sign. Stop signs should not be used at signalized intersections even though the traffic signals may be on flashing red for part of the day or at irregular intervals.

Flashing yellow (caution signal):

When a yellow lens is illuminated with intermittent flashes (50–60 per minute), drivers of vehicles may proceed through the intersection or past such signal with more than ordinary caution.

Steady yellow shall not be used as a caution signal.

3B–6 Vehicular Signal Lenses

The optical unit of a signal consists of a lens, reflector, lamp and lamp socket. The lens is that part of the unit which redirects to the desired area the light from the lamp and its reflector.

All vehicular signal lenses shall be circular in shape, except that green arrow lenses may be rectangular. There shall be two approved sizes for circular lenses, 8 inches and 12 inches nominal diameter (fig. 3–1).

The 8-inch nominal diameter lens shall have a visible diameter of not less than 7¾ inches and an overall diameter of not less than 8⅜ inches. In the past, this has been the only standard size and is therefore the one in most common use.

The 12-inch nominal diameter lens shall have a visible diameter of not less than 11½ inches and an overall diameter of not less than 12-1/32 inches. Experience with this size of lens has been relatively limited, but is sufficiently successful to justify its acceptance, at least for locations where greater signal conspicuousness is needed. The 12-inch red lens is often used with the smaller size yellow and green lenses to give special emphasis to the most restrictive indication. However, all three lenses may be the larger size. The 12-inch lens provides an important increase in the target value of the signal at locations where signal indications tend to be overlooked. Among the situations where 12-inch lenses have been applied are:

1. Rural intersections or those with high approach speeds.
2. Isolated intersections or those where signalization might be unexpected, such as the first signal beyond a freeway exit.
3. Special problem locations such as those with conflicting or competing background lighting.
4. Intersections where drivers view both traffic control and lane-direction-control signals simultaneously.

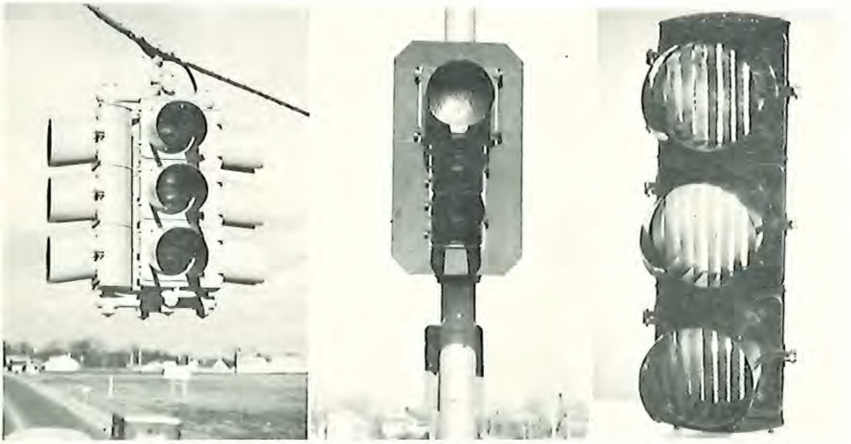

Figure 3–1. ***Typical signal features:*** **Left, overhead span-wire mounted signal with standard 8-inch lenses, shielded by visors; center, post-mounted signal with a 12-inch red lens, shielded by visors and backplate; right, signal lenses shielded by visors with louvers.**

For use in directing vehicular traffic, green arrows shall point out the approximate direction in which movement is permitted. The arrow shall be pointed vertically upward to indicate a straight-through movement, in a horizontal direction to indicate an approximate right-angle turn, and obliquely on an upward slope approximately equal to the angle of the turn when it is substantially different from a right angle.

It is essential that approaching drivers be able to recognize the green arrow shape at a distance of at least 200 feet from the signal.

Each arrow lens shall show only one arrow direction. Double-headed arrows are not acceptable. **The arrow shall be the only illuminated part of the lens. It shall be reproduced on the lens in conformance with the appropriate dimensions and shape for either the 8-inch or 12-inch lens as shown in figure 3–2. All**

lenses shall conform to the latest standards for traffic control signal heads of the Institute of Traffic Engineers.[12]

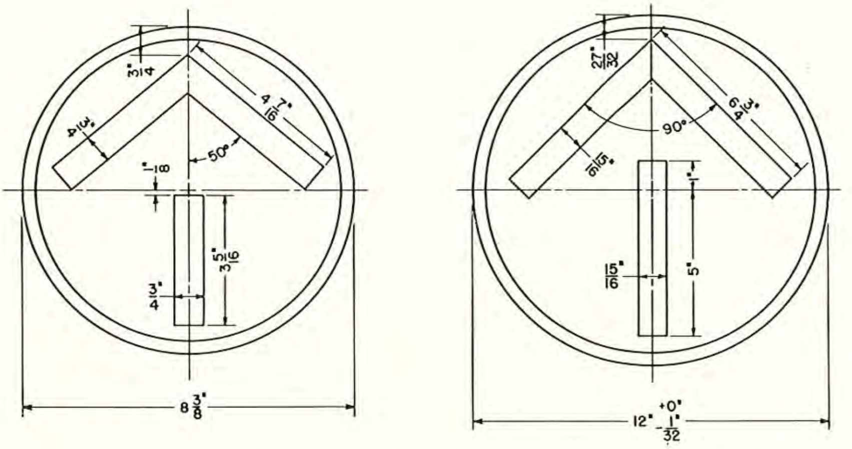

Figure 3–2. Standard arrows for signal lenses (Institute of Traffic Engineers).

3B–7 Lettering on Lenses

Lettering shall in no case be used on the visible part of vehicular signal lenses. The practice of embossing words such as GO and STOP on vehicular signal lenses reduces their effectiveness and is no longer prescribed in the standards for traffic control signal heads.

3B–8 Illumination of Lens

Each lens shall be illuminated independently. This is essential to permit uniform position of lenses, to give satisfactory brilliance, and to provide the necessary flexibility in signal indications. Candlepower charts showing the required distribution of light from each vehicular signal optical unit, and standards for lamp performance, are included in the Institute of Traffic Engineers Technical Report No. 1, cited above in section 3B–6.

3B–9 Visibility and Shielding of Lens

When a vehicular traffic signal lens is illuminated and the view of such an indication is not otherwise physically obstructed, it shall be clearly visible to drivers it controls at distances up to 1,000 feet under all atmospheric conditions except dense fog.

Each signal face shall be so adjusted that its beams will be of

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[12] *Adjustable Face Traffic Control Signal Head Standards,* Technical Report No. 1. Revised 1958, Institute of Traffic Engineers, 2029 K Street, N.W., Washington 6, D.C.

maximum effectiveness to the approaching traffic for which it is intended. Visors, louvers and back-plates often improve a signal's effectiveness (fig. 3–1).

In general, vehicular signals should be so aimed as to have the maximum effectiveness for approaching drivers at a distance from the Stop line equal to the average distance they would travel while reacting to the Stop indication and stopping their vehicles from a normal operating speed. The influence of curves, grades, and obstructions should be considered in the directing and location of signals.

Irregular street design frequently necessitates placing signals for different street approaches so that there is a comparatively small angle between their beams. **In these cases, each signal face shall, to the extent practicable, be so shielded by visors or louvers that an approaching driver can see only the indication intended for him to obey.**

The foregoing does not preclude special aiming of certain lenses so that the driver does not see their indications within the stated ranges of distance if other indications must first be observed and simultaneous viewing of both signal indications could cause the driver to be misdirected.

3B–10 Auxiliary Signs

When auxiliary signs are needed, they shall be reflectorized or preferably illuminated and shall be attached in a suitable position adjacent to the signal assembly (fig. 3–3). Signal heads and auxiliary signs shall be mounted so that the minimum clearances of the total assembly will conform to the provisions of section 3B–13.

Where used in conjunction with traffic signals, illuminated signs should be designed and mounted in such manner as to avoid undesirable glare and reflections in any combination of the signal and sign assemblies. The traffic control signal must be given dominant position and brightness to assure its target priority in the overall display.

3B–11 Types of Mounting for Signal Heads

Types of signal-head mountings include the following:

1. Alongside the roadway:
   - (a) Posts 8 to 15 feet high.
   - (b) Short brackets attached to poles (at same heights).
2. Over or in the roadway:
   - (a) Long brackets or mast arms extending from poles off the roadway.
   - (b) Cable suspension.
   - (c) Posts or pedestals on islands.

Mounting fixtures shall be so designed that horizontal and vertical adjustments are possible through a reasonable angle.

3B–12 Number of Signal Faces

There shall be a minimum of two vehicular signal faces visible to traffic on each approach to a signalized intersection. These shall be supplemented by pedestrian signals, where warranted, located at each end of each controlled crosswalk (sec. 3F–2).

Two (or more) properly located faces will in almost all cases provide drivers with a signal indication even though trucks or buses may momentarily obscure one signal face. Multiple faces provide a safety factor where the signals must compete with a brilliant background such as advertising signs or the sun. The occasional inevitable lamp failure in one face will not leave an approach without any signal indication.

The number of signal faces in excess of two per approach will be dictated by local conditions such as number of vehicular lanes, the need for special turn indications, and the configuration of the intersection and channelizing islands.

3B–13 Location of Signal Faces

The location of signal faces for each direction of approaching traffic shall be as follows:

1. Where all signal faces are post- or pedestal-mounted there shall be at least two on the far side of the intersection.

2. Where there is only one post- or pedestal-mounted signal face, it shall be on the far side, and there shall also be a mast-arm or span-wire mounted signal face for that approach.

3. Where visibility or other conditions require more than one span-wire or mast-arm signal, at least one of the overhead signal faces shall be in line with the approach it controls.

Signal faces shall be located so as to give drivers and pedestrians a clear and unmistakable indication of the right-of-way assignment from their normal positions on the approaches and as they enter or pass through the intersection area. Where pedestrian signals are installed they should conform to the location standards prescribed in section 3F–6. Where separate pedestrian signals are not installed, the vehicular traffic control signals should be located so as to assist pedestrians in determining when it is safe to cross.

Overhead signals are desirable at locations where signals at the side of the roadway are likely to be overlooked, as at isolated rural intersections, or where high-speed routes enter built-up areas, or where advertising signs and other distracting lights interfere with visibility of signals mounted along the roadway. Overhead signals have little value for pedestrian traffic, and post-

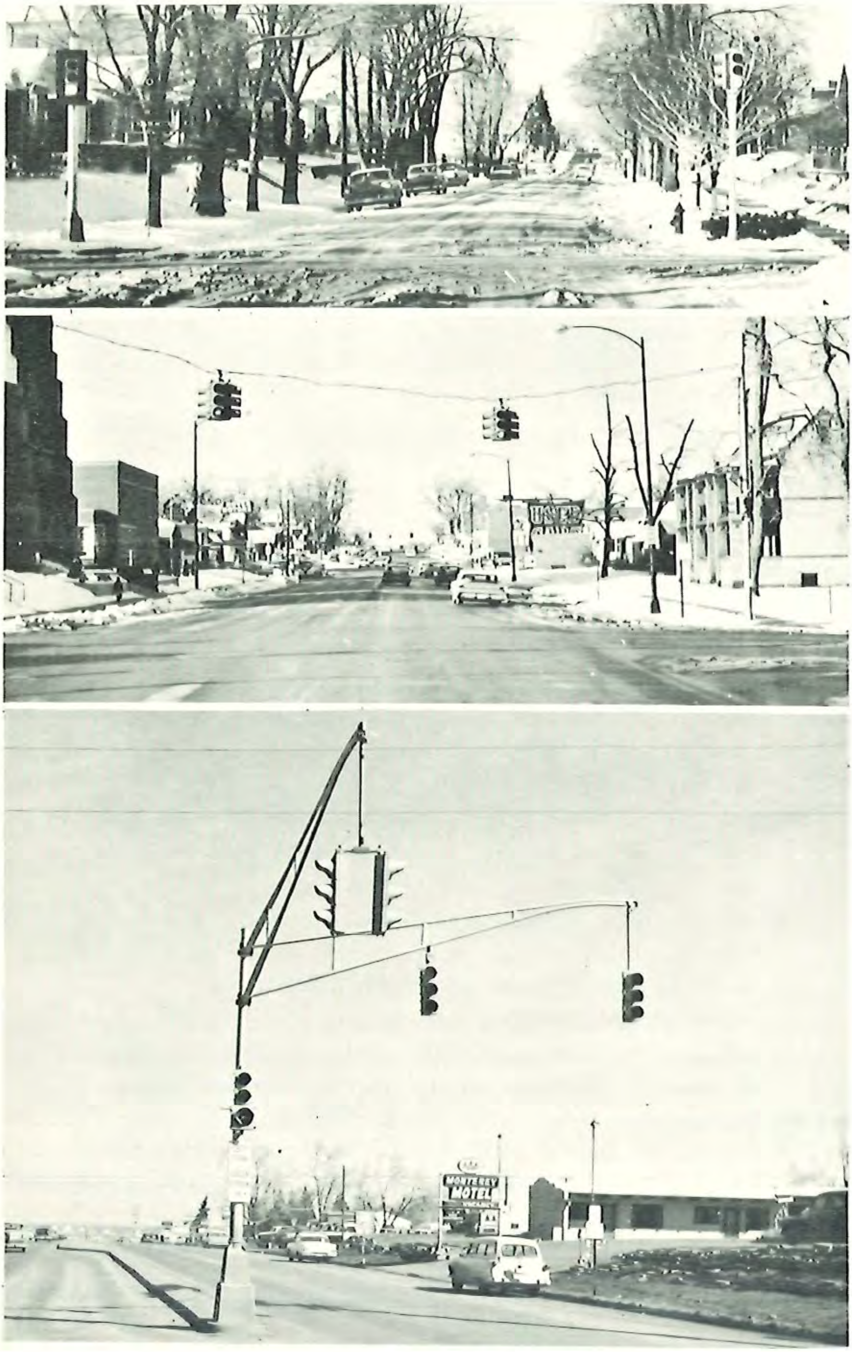
USED
MONTEREY
MOTEL
VACANCY

Figure 3–3. Typical traffic signal installations: **Top,** *post or pedestal mounted.* **Center,** *span-wire mounted.* **Bottom,** *mast-arm mounted; note separate left turn signal and sign, and 12-inch arrow lens.*

mounted signals are commonly used to supplement overhead installations where pedestrian control is important.

Where signals are suspended over the roadway, at least one face of the overhead installation facing each direction of travel should be located so that it will be clearly visible from where vehicles are brought to a stop.

Signals on posts or pedestals located within the roadway should be on properly designed islands and protected by signs and by night illumination.

Figure 3–3 illustrates typical practice for traffic signal mounting.

Where physical conditions prevent a vehicle driver from having a continuous view of at least one signal indication for approximately 10 seconds before reaching the stop line, an auxiliary signal shall be used to provide this visibility. If physical conditions make this impossible, a flashing yellow beacon (sec. 3G–5) or Signal Ahead sign (sec. 1C–16) shall be erected in a suitable position to warn approaching traffic. A flashing yellow beacon utilized in this manner may be interconnected with the intersection signal controller in such manner as to flash yellow during the period when drivers passing this beacon, at the legal speed for the roadway, will encounter a red signal upon arrival at the intersection.

3B–14 Height of Vehicular Signal Faces

The bottom of the housing of a post-mounted signal face shall not be less than 8 feet or more than 15 feet above the sidewalk, or, if none, above the pavement grade of the center of the highway.

The bottom of the housing of signal faces suspended over roadways shall not be less than 15 feet or more than 17 feet above the pavement grade of the center of the roadway.

Maximum visibility and adequate clearance should be the guiding consideration in deciding signal height. Grades on approaching streets may be important factors, however, in determining the most appropriate height.

3B–15 Transverse Location of Signal Faces

Signal faces mounted at the side of a street with curbs or an established curb line shall be located as near as practicable to that curb line, normally with a 2-foot clearance. In the case of nearside locations, they should also be located as near as practicable to the Stop line, or to where the Stop line would normally be. For the protection of the equipment from damage by passing vehicles, it is not desirable that any part of the signal head extend within 2 feet of the curb line. A signal or its support should not obstruct the crosswalk.

Where there is no curb, a signal face mounted at the roadside shall be not more than 10 feet off the edge of pavement or traveled surface, provided that it does not obstruct free use of the shoulder.

A signal face mounted on a span wire or mast arm provides a prominent indication and should be located as near as practicable to the line of the driver's normal view. An auxiliary signal face, either overhead or at the side, should be positioned transversely to give an effective dual indication and to fit the needs at the intersection. Where a signal face controls a specific lane or lanes of the approach, its transverse position should be unmistakably in line with the path of that movement.

3B–16 Limit of Signal-Controlled Area

A signal shall control traffic only at the intersection where the installation is located.

Depending on signals at a few intersections to control traffic at intermediate nonsignalized intersections is uncertain and hazardous. Under such conditions, drivers on cross streets at nonsignalized intersections must often enter the crosswalk to see a signal indication on the main street. Strangers are likely to enter nonsignalized intersections unknowingly, which is obviously hazardous.

3B–17 Removal of Confusing Advertising Lights

The Uniform Vehicle Code (Sec. 11–205) prohibits the display of any unauthorized sign, signal, marking, or device which interferes with the effectiveness of any official traffic control device. The enactment of this provision is particularly important. If enforced it will, among other things, reduce the serious confusion caused by lights similar to traffic control signals in color and location. The steps necessary to eliminate this sort of hazard are warranted.

3B–18 Roadway Widening to Improve Signalization

Widening of both the main highway and the intersecting roadway may be warranted to reduce the delays caused by assignment of right-of-way at intersections controlled by traffic signals. Widening of the intersecting roadway is often beneficial to operation on the main highway because it reduces the signal time that must be assigned to side-street traffic. In urban areas the effect of widening can be achieved by elimination of parking at intersectional approaches.

Additional width may be necessary on the leaving side of the intersection as well as the approach side in order to clear traffic through the intersection effectively.

3B–19 Provision for Future Installation

When future traffic needs, or physical changes in intersection design, can be foreseen, provision for these should be made in planning for signalization to minimize material and labor costs. This is illustrated by the following examples:

If future land development is likely to create justification for a pedestrian signal, the controller should be equipped with extra circuits to provide for future pedestrian intervals.

If a street is to be widened or an intersection is to be reconstructed in the predictable future, either a temporary signal installation or an installation to conform to the proposed final layout should be considered.

If future interconnection or vehicular turning intervals can be predicted, provisions for these should be incorporated in the controller.

3B–20 Signal Cable

The reliable and economical operation of a signal system is as dependent upon its cables or other means of interconnection as upon the other signal equipment. The International Municipal Signal Association Specifications for Wire and Cable are recommended as a guide for procurement of signal cable.[13]

3B–21 Efficiency and Continuity of Operation

The full utility of traffic signals is realized only when they are operated in accordance with actual traffic requirements. Inconvenience, disobedience, and hazard follow unnecessary, arbitrary, or inaccurate operation. The operating standards contained in this Manual provide for a reasonable efficiency in the operation of signals at warranted locations.

It is desirable that a person approaching a traffic signal should presume it is functioning unless he is given a conspicuous and specific indication to the contrary. Hence it is required that all signals in use be "live." When not operating as a stop-and-go device, the signal should be operated as a flashing device (secs. 3D–3, 3E–27).

Prior to placing signals in service and during seasonal shutdowns, when it is not desirable to operate the signals, they should be hooded, turned, or taken down so persons will be under no misapprehension that a lamp may be burned out.

3B–22 Unexpected Conflicts During Green Interval

No movement that may involve an unexpected crossing of pathways of moving traffic should be permitted during any green interval, except under unusual conditions when:

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[13] *Specifications for Municipal Communication Control, Signal and Power Cables.* International Municipal Signal Association, 130 West 42d Street, New York 36, N.Y.

1. The movement involves only slight hazard;
2. Serious traffic delays are materially reduced by permitting the conflicting movement; and
3. Drivers and pedestrians subjected to the unexpected conflict are effectively warned thereof.

When such conditions of possible unexpected conflict exist, warning may be given by a sign or, under certain conditions, by the use of a flashing yellow or red signal instead of a green signal. The foregoing applies to vehicle-pedestrian conflicts as well as to vehicle-vehicle conflicts.

3B–23 Vehicle-Clearance Interval

A yellow vehicle-clearance interval shall be used following each green interval and, where applicable, after each green arrow interval. In no case shall a yellow interval be displayed in conjunction with the change from red to green. In order to avoid doing so, the use of separate signal faces is recommended when traffic movements are controlled by green arrows (sec. 3B–5, Green Turn Arrow).

The functions of the yellow interval should be exclusively to warn traffic of an impending change in the right-of-way assignment and to permit clearance of the intersection.

In general, the vehicle-clearance interval should be not less than 3 seconds nor more than 5 seconds in length. While clearance intervals longer than 5 seconds may occasionally be necessary at very wide intersections or under other unusual conditions, they are likely to cause impatience among drivers awaiting the signal change and consequent starting before the green indication appears. Under such conditions it has been found more satisfactory to supplement the normal yellow period with a short all-way red interval of sufficient duration immediately after the yellow period to permit the intersection to clear before cross traffic is released (sec. 3B–5).

3B–24 Flashing Operation of Traffic Control Signals

Flashing operation of a standard traffic control signal involves intermittent illumination of the red or yellow lens in each face. Traffic control signals are placed in flashing operation under the conditions prescribed in sections 3D–3 and 3E–27. The meaning of flashing yellow and flashing red is described in section 3B–5.

When signals normally operated as stop-and-go signals are put on flashing operation, the color indications given to the several streets should be based on the following considerations:

1. If one of the streets involved is a through street, it should be given a flashing yellow (caution) indication and the other approaches should be given a flashing red (stop) indication.

2. If the safe approach speed on one street differs from the safe approach speed on the other street or streets, the street having the higher safe approach speed should be given the flashing yellow (caution) indication and other approaches should be given a flashing red (stop) indication.

3. If safe approach speeds and traffic volumes on both streets are comparable or not significantly different, the traffic signal may be operated as flashing red for both streets.

The control of flashing operation of standard signals should be provided by an electrical mechanism supplementary to the signal timer. The signal timer should be removable without affecting the flashing operation. The mechanism operates in a manner similar to that of a flashing beacon (sec. 3G–2) to provide intermittent illumination of selected signal lenses. **The illuminating element in a flashing signal shall be flashed continuously at a rate of not less than 50 nor more than 60 times per minute. The illuminated period of each flash shall be not less than half and not more than two-thirds of the total flash cycle.**

In every case the change from flashing to stop-and-go operation should be made at the beginning of the common main-street green interval (i.e., when a common green indication is shown in both directions on the main street), and no change from flashing yellow to steady red is permissible without an intervening steady yellow. If, when in flashing operation, the signals flash yellow on the main street, the change from stop-and-go to flashing operation should be made during the common main-street green period; and if, when in flashing operation, the signals flash red on the main street, the change from stop-and-go to flashing operation should be made immediately following the main-street clearance interval.

3B–25 Traffic Signals Near Grade Crossings

At some street and highway intersections, railroad tracks pass within or near the intersection area, and the grade crossing thus formed is protected by train-approach signals (secs. 3H–1 to 9). At such intersections it is essential that the control of the street traffic signal be preempted from the signal controller upon approach of trains to avoid conflicting aspects of the traffic signal and train-approach signal. Such an arrangement requires a closed electrical circuit between the control relay of the train-approach signals and the preemptor in order to establish and maintain the preempted condition during the time that train-approach signals are in operation.

Traffic signals shall not be used in lieu of railroad grade crossing protection devices. There are, however, some crossings where train movements are regulated to the extent that train-approach signals are not required. In such cases preemption at the adjacent signalized intersections may be desirable to permit nonconflicting highway traffic to proceed during the time the crossing is blocked by a train. Except under unusual circumstances the interconnection should be limited to the traffic signals within 200 feet of the crossing.

There is a great diversity of configuration of intersection patterns involving railroad tracks. At some locations one or more tracks directly traverse the intersection area. At other locations the trackage cuts across one or more approaches. There are all degrees and combinations of vehicle volume, train frequencies, and waiting times.

There is, however, one fundamental requirement which must be observed in all cases. **The preemption sequence initiated when the train first enters the approach circuit shall at once bring into effect a signal display which will permit all vehicles to clear the tracks before the train reaches the intersection.**

To increase the safety factor at the railroad crossing, the normal sequence (no trains involved) of the traffic signals should be so designed that vehicles are not required to stop on the tracks even though in some cases this will increase the waiting time.

The exact nature of the signal display and location of the signals to accomplish this will depend on the physical relationship of the trackage to the intersection area. It is imperative, however, that the first stage of the preemption sequence be designed to clear vehicles from the tracks.

At the completion of the first stage of the preemption sequence, a second stage will come into effect which will persist until the preemption signal from the railroad control circuit ceases. The nature of this stage will depend upon the geometrics of the intersection and the nature and importance of the traffic flow, but will in all cases prohibit movements over the tracks. This stage may be steady red or flashing red. It may permit by arrow indications certain vehicle movements which do not cross over the tracks, and there may even be some transfer of nonconflicting rights-of-way during the preemption period. Naturally the probable duration of this period is a factor in all of the above.

When the train clears the crossing it is necessary to return the signal to a designated phase, this being the final stage of the preemption sequence.

When the green indication is preempted by train operation, a yellow clearance interval must be inserted in the signal sequence in the interests of safety and smoothness. To avoid misinterpretation during the time that the clear-out signals are green, consideration should be given to the use of 12-inch red lenses in the signals which govern movement over the tracks (sec. 3B–6).

Careful consideration needs to be given the control of all intersections involving train movements. The plan for signal control must be based on the specific factors that prevail at each intersection involved. The preemption equipment tends to be special for each case and frequently of considerable complexity.

3B–26 One-Way Restricted Zone Control

Control equipment is available for use at a narrow passage, such as a bridge, tunnel, or construction area, which is not wide enough to allow traffic to flow in opposite directions simultaneously. This operates essentially as a two-phase control, each approach being one phase, with an all-red clearance period added to the normal cycle. Traffic moves in one direction on one phase and in the opposite direction on the other phase. Between these movements the all-red interval provides time for clearance of such traffic as may be in the restricted area.

3B–27 Emergency and Civil Defense Operation of Traffic signals

Traffic signals operated under emergency conditions shall use color sequences with which drivers and pedestrians are familiar. Nonstandard colors, unusual flashing cycles, or flashing of yellow lights in signal assemblies while regular traffic signal operation goes on in the same assembly are to be avoided. This does not preclude, and in some cases will necessitate, the use of auxiliary indications independent of the traffic signal assembly to indicate the existence of an emergency condition.

Devices used on emergency vehicles to preempt (by radio) intersectional traffic signal control shall operate at a range sufficient to permit a normal clearance interval to take place in the change from green to yellow to red (or flashing red) before arrival of the emergency vehicle at the preempted location. Systems in which intersectional traffic signal control is preempted by emergency vehicles shall be designed and installed so as to provide a fail-safe indication to the driver of any emergency vehicle approaching an intersection whose equipment fails to preempt the traffic signal at that intersection. This fail-safe indication shall be given whether the failure results from a prior preemption by an emergency vehicle on the cross street, from equipment malfunction, or from any other cause.

Traffic signals operating in congested areas during emergency or civil defense conditions shall, as far as possible, be operated in a manner designed to keep traffic moving. Prolonged all-red or flashing signal sequences are to be avoided because of confusion, hazard, and delays caused by stoppage of traffic movement.

3B–28 Adequacy of Maintenance

Much of the authority and respect that traffic signals have may be traced to their clear-cut compelling indications. Signals with impaired efficiency cannot be expected to command the necessary degree of respect. Proper maintenance is, therefore, of primary importance from this functional viewpoint, and will pay other dividends in increasing the effective life of the signal equipment.

Maintenance should be an important consideration in the design and purchase of traffic signal equipment. If low first cost is followed by high maintenance costs or by serious losses of efficiency, it is obviously poor economy.

The standards set forth in sections 3B–29 to 3B–33 are intended to provide the essential features for an adequate maintenance program.

3B–29 Signal Lamp Replacement

Burned-out lamps convert traffic signals to the role of a traffic hazard. Immediate replacement of such lamps, and scheduled group replacement of lamps short of their anticipated life, are extremely important maintenance functions. The use of two signal faces for each approach roadway is an important factor in providing safety when a signal lamp burns out unexpectedly.

Remoteness of signals from maintenance facilities often entails delay in replacement of burned-out lamps. In maintenance jurisdictions having remote signals a regular lamp-replacement schedule is advised. Such a schedule should provide for replacement slightly short of the lamp-life expectancy as determined from consideration of the following factors:

1. Probabilities of lamp failure as applied to mass production and manufacturers' rating.
2. The effect on lamp life of the difference between the voltage at the lamp socket and the rated voltage.
3. The failure or reduction of lamp-life expectancy due to vibration in normal operation and as a result of lamp handling.

Actual hours of illumination for lamps vary according to lens position and timing schedules. For example, major-street green and minor-street red will require replacement more often than minor-street green and major-street red. These latter in turn will require replacement more often than the yellow.

3B–30 Cleaning

The reduction in brilliancy of a signal indication resulting from even a moderate amount of dust and dirt is generally very much underestimated. Signal lenses, reflectors, and lamps should be thoroughly cleaned at least once every 6 months. Lenses and reflectors should always be cleaned when lamps are replaced, unless the last regular cleaning has been very recent.

The frequency with which cleaning is required will vary according to the location of the signal. Signals located in industrial or other areas where the air is dusty or polluted, or in areas where chemical fumes are present, will generally require more frequent cleaning than those in residential areas. Lenses lose efficiency due to the action of wind-blown grit. At the time of cleaning, lenses in poor condition should be replaced. Some lenses, however can be restored to usable efficiency by chemical treatment. When glass reflectors are to be cleaned, the use of abrasive agents should be avoided to prevent loss of reflective efficiency from scratches. Special cleaners are required to clean polished aluminum reflectors properly.

3B–31 Location and Maintenance of Controllers

Controllers should be located where the likelihood of damage by motor vehicles is minimized. They should be located so that the service man can stand in a protected area and can have a clear view of the signal units being controlled.

Every controller shall be kept in effective operation in strict accordance with its predetermined timing schedule.

Timing.—**A careful check of the correctness of timed operation of the controller shall be made frequently enough to insure its operating in accordance with the planned timing schedule.** To check the timing, the length of each interval should be recorded for at least two complete cycles. These should then be checked against the timing schedule, a copy of which should be posted in the control-box cabinet. A complete check of traffic-actuated equipment should include the checking of the maximum timing by temporarily grounding the detector inputs in the controller. Where the controller is capable of operating in more than one dial, split, or offset, each should be independently checked. The checking of offsets can be facilitated by the preparation of a timetable for each controller in the system, and by the operation of the system on a predetermined cycle length during the time that the check is being made.

The checking of most timing functions can be done effectively in connection with periodic preventive maintenance or overhaul. The necessity for checking timing arises from the possibility of mechanical or electrical misadjustments or unauthorized changes of timing. The correction of faulty timing should be done only by capable, trained persons who have been duly authorized to perform controller repairs. Timing changes should be made only by authorized persons, using written instructions which describe details of each change.

Preventive maintenance.—**Controllers shall be carefully cleaned and serviced at least as frequently as specified by the manufacturer and more frequently if experience proves it necessary.**

Regularly scheduled preventive maintenance has been found to be more economical than waiting for serious controller trouble to occur. Some manufacturers recommend at least a yearly schedule.

Preventive maintenance servicing should include several steps. Controllers should be lubricated as shown in the manufacturer's instructions, but lubrication of other controller parts such as sealed bearings should be avoided. Electrical contacts, bearings, and wiring should be inspected and any worn or weak parts should be replaced. An accuracy check should be made of all timing motors, including synchronous, induction, and frequency responsive motors.

In the adjustment and overhauling of controllers, the tools recommended by the equipment suppliers should be used.

Availability of a spare unit for each type of controller minimizes the interruption to signal operation when a controller must be removed for routine servicing or emergency repair.

3B–32 Painting

Signal heads, brackets, poles, posts, control boxes, housings, and conduits above ground should be repainted at least every 2 years, and as much oftener as may be necessary to prevent corrosion and to maintain the good appearance of the equipment.

The frequency with which repainting is needed will vary with the paint, the condition of the surface to which it is applied, chemicals in the atmosphere, nearness to salt water, and other conditions.

The insides of visors or hoods and the entire surface of louvers or fins used in front of signal lenses shall be painted a dull black to minimize light reflection to the side of the signals. This is necessary for the same reasons as is adequate shielding of signal lenses (sec. 3B–9).

It is advisable to paint signals with colors which contrast with the visual background or with the light output of the signals. Highway yellow, dark green, and black have all been effectively used alone and in combination. Use of aluminum or silver paint which blend with the sky on bright days should be avoided.

3B–33 Maintenance Records

Detailed maintenance records should be kept and analyzed at regular intervals to determine future policies as to equipment purchases and the maintenance program.

Good maintenance records are valuable in a number of ways:

1. Careful analysis will assist in determining whether or not the maintenance program in use is satisfactory.
2. Analysis of costs will aid in deciding upon types of equipment to be purchased and improvements in maintenance methods.
3. Maintenance records will frequently be needed by the courts in connection with accident cases.

Maintenance records should indicate the necessary time required and costs of cleaning, lubrication, retiming, overhauling, lamp replacement, painting, and similar items for each signal installation, for each specific controller, and for each specific lamp failure.

C—COMPARISON OF PRETIMED AND TRAFFIC-ACTUATED CONTROL

Section 3C–1 Relative Adaptability to Normal Intersection Requirements

Each of the principal types of traffic signal control, pretimed and traffic-actuated, possesses certain advantages not afforded by the other. The choice of equipment should be made only after a review of the relative merits and adaptability to the particular requirements at the location proposed for signalization. The following discussion is intended to bring out basic differences in the different types of control, insofar as their operating characteristics and suitability for various traffic requirements are concerned. It should be remembered that each type of control is capable of being modified in various ways for improved efficiency and flexibility of traffic control.

With basic pretimed control, a consistent and regularly repeated sequence of signal indications is given to traffic. The total cycle length required for a complete sequence of indications may be adjusted from a minimum of 30 seconds to a maximum of about 120 seconds. In most basic pretimed controllers, changes in cycle length may be made in 5-second increments. By use of attached auxiliary devices or remotely located supervisory equipment to be discussed in sections to follow, the operation of pretimed control can be changed within certain limits to meet requirements of traffic more precisely.

Pretimed control is best suited to intersections where traffic patterns are relatively stable or where the variations in traffic that do occur can be accommodated by a pretimed schedule without causing unreasonable delays or congestion. Pretimed control is particularly adaptable to intersections where it is desired to coordinate operation of signals with existing or planned signal installations at nearby intersections on the same street or adjacent streets.

The traffic-actuated controller differs basically from the pretimed controller in that signal indications are not of fixed length, but are determined by and conformed within certain limits to the changing traffic flow as registered by various forms of vehicle and pedestrian detectors. The length of cycle and the sequence of intervals may or may not remain the same from cycle to cycle, depending on the type of controller and auxiliary equipment utilized to fit the needs of the intersection. In some cases certain intervals may be omitted when there is no actuation or demand from waiting vehicles or pedestrians.

Many operating variations are possible with traffic-actuated control. An intersection may be semi-traffic-actuated, which means that the green light is normally given to, and held by, the major street until a minor-street demand is registered. The green light is then given to the minor street for a period of time related to demand and then returned to the major street. This type of control finds frequent application at the intersection of an arterial street with a side street having relatively light and irregular vehicle and pedestrian traffic. By means of auxiliary devices, semi-traffic-actuated controllers can be coordinated with traffic signals at adjacent intersections, although this coordination is not usually as precise as with pretimed control.

Full traffic-actuated control provides for detector actuations on all approaches to the intersection. The controller is thus enabled to assign right-of-way substantially in accord with the demands of the several approaches. Some of these controllers are also capable of taking into account certain characteristics such as the spacing of approaching traffic and the waiting time of stopped vehicles.

For the signalization of arterial streets and of areas, a form of control termed "traffic-adjusted" is available which has some of the characteristics of both traffic-actuated and pretimed operation. Detectors are not used at each intersection, but the overall traffic demands are determined by sampling traffic volumes by automatic counting detectors at key locations. Computing equipment at a central control location constantly receives information from the sampling detectors, and adjusts the signal display within certain limits either continuously or at fixed intervals so as to provide optimum movement with respect to the currently dominant volumes and directions of vehicle movement.

3C–2 Advantages of Pretimed Control

Among the advantages of pretimed control are the following:

1. Consistent starting time and duration of intervals of pretimed control facilitates coordination with adjacent traffic signals, and provides more precise coordination than does traffic-actuated control, especially when coordination is needed with adjacent traffic signals on two or more intersecting streets, or in a grid system. This coordination may permit progressive movement and a degree of speed control through a system of several well-spaced traffic signals. Precise coordination may also permit maximum efficiency in the operation of two or more very closely spaced intersections operating under capacity conditions, when the timing relationship between intersections is critical.
2. Pretimed controllers are not dependent for proper operation on the movement of approaching vehicles past detectors. Thus the operation of the controller is not adversely affected by conditions preventing normal movement past a detector, such as a stopped vehicle or construction work within the area.
3. Pretimed control may be more acceptable than traffic-actuated control in areas where large and fairly consistent pedestrian volumes are present, and where confusion may occur as to the operation of pedestrian push buttons.
4. Generally the installed cost of pretimed equipment is less than that of traffic-actuated equipment and the former is simpler and more easily maintained.

A degree of simple coordination of pretimed controllers can be attained by use of controllers equipped with synchronous timing motors without wire interconnection or remote supervision. However, due to interruptions or irregularities of electric service which may occur, frequent patrol and adjustment of signals is required to assure reliable coordination in the absence of supervisory circuits.

3C–3 Advantages of Traffic-Actuated Control

At intersections where traffic volumes fluctuate widely and irregularly, where traffic loads shift frequently, or where interruptions to main-street flow must be minimized, maximum efficiency in signal operation may be attained by the used of traffic-actuated control.

Among the special advantages of traffic-actuated control are the following:

1. Traffic-actuated control may provide maximum efficiency at intersections where fluctuations in traffic cannot be anticipated and programed for with pretimed control.
2. Traffic-actuated control may provide maximum efficiency at complex intersections where one or more movements are sporadic or subject to variation in volume.
3. Traffic-actuated control will usually provide maximum efficiency at intersections of a major street and a minor street by interrupting the major-street flow only when required for minor-street vehicular or pedestrian traffic, and also by restricting such interruptions to the minimum time required.
4. Traffic-actuated control may provide maximum efficiency at intersections unfavorably located within progressive pretimed systems, where interruptions of major-street traffic are undesirable and must be held to a minimum in frequency and duration. A background time cycle may be superimposed upon the operation to effect coordination with nearby signals (sec. 3E–8).
5. Traffic-actuated control may provide the advantages of continuous stop-and-go operation without unnecessary delay to traffic on the major street, whereas isolated pretimed signals are sometimes switched to flashing operation during periods of light traffic.
6. Traffic-actuated control is particularly applicable at locations where traffic signal control is warranted for only brief periods during the day.
7. Traffic-actuated control tends to reduce any hazard associated with the arbitrary stopping of vehicles.

3C–4 Other Factors Governing Selection of Type of Control

The choice between pretimed and traffic-actuated control is frequently determined by initial equipment cost, installation cost, and anticipated operating expenses. Pretimed control is generally less expensive to install and maintain than other types of control. In considering the economic aspects in the selection of appropriate control apparatus, however, careful attention should be given to economic benefits or losses which may accrue to motorists and pedestrians. Unnecessary stoppages and delays to traffic movement result in economic losses which accumulate to a significant total during the life of the traffic control equipment. In many cases the reduction in motor-vehicle operating costs will justify installation of signal control equipment which has a higher first cost but greater efficiency in handling traffic.

Accident hazards also should be considered. While signals are most effective in reducing right-angle collisions, they tend to increase the frequency of rear-end collisions. Possible reduction of accidents through efficient operation of traffic signals frequently will offset added signal installation and maintenance costs.

Extreme care should be used in selecting traffic control equipment so that proper features for present and future operation will be obtained when controllers are purchased or can be added at a later date without excessive cost.

D—PRETIMED SIGNALS

Section 3D–1 Definition

A pretimed signal is a traffic control signal which directs traffic to stop and permits it to proceed in accordance with a single predetermined time schedule or a series of such schedules.

Operational features of pretimed signals, such as cycle length, split, sequence, offset, etc., can be changed according to a predetermined program.

3D–2 Advance Engineering Data Required

A comprehensive investigation of traffic conditions and physical characteristics of the intersection is required to determine the necessity for a signal installation and to furnish necessary data for the proper design and operation of a signal that is found to be warranted. Such data should desirably include:

1. The number of vehicles entering the intersection in each hour from each approach during 16 consecutive hours of a representative day. The 16 hours selected should contain the greatest percentage of the 24-hour traffic.

2. Vehicular volumes for each traffic movement from each approach, classified by vehicle type (heavy trucks, passenger cars and light trucks, and public-transit vehicles), during each 15-minute period of the two hours in the morning and of the two hours in the afternoon during which total traffic entering the intersection is greatest.

3. Pedestrian volume counts on each crosswalk during the same periods as the vehicular counts in paragraph 2 above and also during hours of highest pedestrian volume. Where young or elderly persons need special consideration, the pedestrians

may be classified by general observation and recorded by age groups as follows:

(a) Under 13 years.
(b) 13 to 60 years.
(c) Over 60 years.

4. The 85-percentile speed of all vehicles on the uncontrolled approaches to the intersection.

5. A condition diagram showing details of the physical layout, including such features as intersectional geometrics, channelization, grades, sight-distance restrictions, bus stops and routings, parking conditions, pavement markings, street lighting, driveways, location of nearby railroad crossings, distance to nearest signals, utility poles and fixtures, and adjacent land use.

6. A collision diagram showing accident experience by type, location, direction of movement, severity, time of day, date, and day of week for at least one year.

Additional data.—The following data are also desirable for a more precise understanding of the operation of the intersection and may be obtained during the periods specified in paragraph 2 above.

1. Vehicle-seconds delay determined separately for each approach.

2. The number and distribution of gaps in vehicular traffic on the major street when minor-street traffic finds it possible to use the intersection safely.

3D–3 Warrants for Pretimed Signals

Pretimed signals may be installed and operated only when one or more of the warrants defined in sections 3D–4 to 9 are satisfied, except that at intersections sufficiently far from other signalized intersections so that progressive timing is generally impractical, or at secondary intersections within a coordinated system, a traffic-actuated signal may be more appropriate than a pretimed signal. If traffic-actuated signals are installed at intersections within a coordinated system, such signals should be equipped and operated with control devices which provide proper coordination with adjacent signals. Sections 3E–2 and 3E–3 describe other warrants for traffic-actuated signals.

The investigation of the need for signal control should include an analysis of the degree to which each of the following warrants is met:

Warrant 1.—Minimum vehicular volume.
Warrant 2.—Interruption of continuous traffic.
Warrant 3.—Minimum pedestrian volume.

Warrant 4.—Progressive movement.
Warrant 5.—Accident experience.
Warrant 6.—Combinations of warrants.

When for a period of four or more consecutive hours any traffic volume drops to 50 percent or less of the stated volume warrants, it is desirable that flashing operation be substituted for conventional operation for the duration of such periods. However, such flashing operation should be restricted to no more than three separate periods during each day. (See sec. 3B–24 for additional discussion of flashing operation of traffic signals.)

3D–4 Warrant 1, Minimum Vehicular Volume

The minimum vehicular volume warrant is intended for application where the volume of intersecting traffic is the principal reason for consideration of signal installation. The warrant is satisfied when for each of any 8 hours of an average day the traffic volumes given in table 2 exist on the major street and on the higher-volume minor-street approach to the intersection.

Table 2.—Minimum vehicular volumes for warrant 1

Number of lanes for moving traffic on each approach		Vehicles per hour on major street (total of both approaches)	Vehicles per hour on higher-volume minor-street approach (one direction only)
Major street	Minor street		
1	1	500	150
2 or more	1	600	150
2 or more	2 or more	600	200
1	2 or more	500	200

The major-street and the minor-street volumes are for the same 8 hours. During those 8 hours the direction of higher volume on the minor street may be on one approach during some hours and on the opposite approach during other hours.

When the 85-percentile speed of major-street traffic exceeds 40 miles per hour, or when the intersection lies within the built-up area of an isolated community having a population less than 10,000, the minimum vehicular volume warrant is 70 percent of the requirements above, in recognition of differences in the nature and operational characteristics of traffic in urban and rural environments and smaller municipalities.

3D–5 Warrant 2, Interruption of Continuous Traffic

The interruption of continuous traffic warrant is intended for application where operating conditions on a major street are such that the minor-street traffic suffers undue delay or hazard in entering or crossing the major street. The warrant is satisfied when for each of any 8 hours of an average day the traffic volumes given in table 3 exist on the major street and on the higher-volume minor-street approach to the intersection, and the signal installation will not seriously disrupt progressive traffic flow.

Table 3.—Minimum vehicular volumes for warrant 2

Number of lases for moving traffic on each approach		Vehicles per hour on major street (total of both approaches)	Vehicles per hour on higher-volume minor-street approach (one direction only)
Major street	Minor street		
1	1	750	75
2 or more	1	900	75
2 or more	2 or more	900	100
1	2 or more	750	100

The major-street and minor-street volumes are for the same 8 hours. During those 8 hours the direction of higher volume on the minor street may be on one approach during some hours and on the opposite approach during other hours.

When the 85-percentile speed of major-street traffic exceeds 40 miles per hour, or when the intersection lies within the built-up area of an isolated community having a population less than 10,000, the interruption of continuous traffic warrant is 70 percent of the requirements above, in recognition of differences in the nature and operational characteristics of traffic in urban and rural environments and smaller municipalities.

3D-6 Warrant 3, Minimum Pedestrian Volume

The minimum pedestrian volume warrant is satisfied when for each of any 8 hours of an average day the following traffic volumes exist:

1. On the major street 600 or more vehicles per hour enter the intersection (total of both approaches); or 1,000 or more vehicles per hour (total of both approaches) enter the intersection on the major street where there is a raised median island 4 feet or more in width; and
2. During the same 8 hours as in paragraph 1 there are 150 or more pedestrians per hour on the highest volume crosswalk crossing the major street.

When the 85-percentile speed of major-street traffic exceeds 40 miles per hour, or when the intersection lies within the built-up area of an isolated community having a population of less than 10,000, the minimum pedestrian volume warrant is 70 percent of the requirements above, in recognition of differences in the nature and operational characteristics of traffic in urban and rural environments and smaller municipalities.

A signal installed under this warrant at an isolated intersection should be of the semi-traffic-actuated type with push buttons for pedestrians crossing the main street. If such a signal is installed at an intersection within a coordinated system, it should be equipped and operated with control devices which provide proper coordination.

Signals installed under this warrant shall be equipped with pedestrian indications as provided in section 3F–2.

In connection with traffic control signals installed for school crossings, it should be understood that a traffic signal is not the only remedy nor is it necessarily the correct solution to the perplexing problem of traffic conflicts between vehicles and school children. Brief periods during which the hazards are unusually high are often better handled by officer control or adult crossing guards.

In some circumstances the pupils' response to traffic signal indications is so inadequate that the signal can become a contributory factor in increasing rather than decreasing accidents. The response to officer control or adult crossing guards is usually less uncertain.

It is therefore believed that traffic control signals should not ordinarily be installed at school crossings where schoolboy patrols or adult crossing guards can be used effectively, where students can be directed to cross at locations which are already controlled by traffic control signals or police officers, or where pedestrian refuge islands provide adequate protection.

Complete facts should be obtained and studied by competent traffic engineering authorities before decisions are made on the installation of signals in the vicinity of schools. As a result of these studies and consideration of the control methods listed above, traffic signals may be warranted if:

1. Pedestrian crossing volumes at a designated school crossing on the major street exceed 250 pedestrians in each of 2 hours; and
2. During each of the same 2 hours vehicular traffic through the designated school crossing exceeds 800 vehicles; and
3. There is no traffic signal within 1,000 feet of the crossing.

When the 85-percentile speed of major-street traffic exceeds 40 miles per hour or when the intersection lies within the built-up area of an isolated community having a population less than 10,000, the warrant is 70 percent of the requirements above, in recognition of differences in the nature and operational characteristics of traffic in urban and rural environments and smaller municipalities.

School crossing signals installed under this warrant should be of the pedestrian-actuated type. **They shall be equipped with pedestrian indications (sec. 3F–2).**

3D–7 Warrant 4, Progressive Movement

Progressive movement control sometimes necessitates traffic signal installations at intersections where they would not otherwise be warranted in order to maintain proper grouping of vehicles and effectively regulate group speed. The progressive movement warrant is satisfied when:

1. On an isolated one-way street or on a street which preponderantly has unidirectional traffic significance, adjacent signals are so far apart that the desired degree of platooning and speed control of vehicles would otherwise be lost.
2. On a two-way street, adjacent signals do not provide the desired degree of platooning and speed control; and the proposed and adjacent signals can constitute a progressive signal system.

Table 4.—System design speeds in relation to cycle length and signal spacing for single-alternate systems[1] [2]

Cycle length of system	Design speed for signal spacing of—		
	1,320 feet (1/4 mile)	1,000 feet (approx. 3/16 mile)	660 feet (1/8 mile)
Seconds	*M.p.h.*	*M.p.h.*	*M.p.h.*
40	45	34.1	22.5
45	40	*30.3*	20
50	36	*27.3*	18
55	32.7	*24.8*	16.4
60	*30*	22.7	15
65	*27.7*	21	13.8
70	*25.7*	19.5	12.9
75	24	18.2	12
80	22.5	17.1	11.3

[1] With identical speeds in both directions.

[2] Italicized numbers represent practical speeds.

In a single-alternate signal system (sec. 3D–19) the minimum spacings between the proposed signal and existing adjacent signals should closely approximate the distance D in feet, or full unit multiples thereof, given by the formula $D = CS \div 1.364$, where C = cycle length in seconds, and S = design speed of signal system in miles per hour. Table 4, illustrating the relationship between cycle length, signal spacing, and system speed, shows that signal spacings under 1,000 feet are not capable (with practical cycle lengths) of rendering progressive, two-way movement with acceptable speeds. It further indicates that desirable minimum signal spacing with 60-, 65-, or 70-second cycle lengths is approximately 1,320 feet or ¼ mile. The italicized speeds represent the practical speed ranges described above.

3D–8 Warrant 5, Accident Experience

The common opinion of the general public that signals materially reduce the number of accidents is rarely substantiated by experience. Not infrequently there are more accidents with signals in operation than before signal installation. Hence, if none of the warrants except the accident experience warrant described below is fulfilled, the initial presumption should be against signalization. Signals should not be installed on the basis of a single spectacular accident or on the basis of unreasonable demands and dire predictions of accidents which allegedly might occur. The accident-experience warrant is satisfied when:

1. Adequate trial of less restrictive remedies with satisfactory observance and enforcement has failed to reduce the accident frequency; and
2. Five or more reported accidents of types susceptible of correction by a traffic control signal have occurred within a 12-month period, each accident involving personal injury or property damage to an apparent extent of $100 or more; and
3. There exists a volume of vehicular and pedestrian traffic not less than 80 percent of the requirements specified in the minimum vehicular-volume warrant, the interruption of continuous traffic warrant, or the minimum pedestrian-volume warrant; and
4. The signal installation will not seriously disrupt progressive traffic flow.

Any signal installed solely on the accident experience warrant should be semi-traffic-actuated with control devices which provide proper coordination if installed at an intersection within a coordinated system, and normally should be full traffic-actuated if installed at an isolated intersection.

A traffic control signal, when obeyed by drivers and pedestrians, can be expected to eliminate or reduce materially the number and seriousness of the following types of accidents:

1. Those involving substantially right-angle collisions or conflicts, such as occur between vehicles on intersecting streets.
2. Those involving conflicts between straight-moving vehicles and crossing pedestrians.
3. Those between straight-moving and left-turning vehicles

approaching from opposite directions, if an independent time interval is allowed during the signal cycle for the left-turn movement.

4. Those involving excessive speed, in cases where signal coordination will restrict speed to a reasonable rate.

On the other hand, traffic control signals cannot be expected to reduce the following types of accidents:

1. Rear-end collisions, which often increase after signalization.
2. Collisions between vehicles proceeding in the same or opposite directions, one of which makes a turn across the path of the other, particularly if no independent signal interval is provided for these turn movements.
3. Accidents involving pedestrians and turning vehicles when both move during the same interval.
4. Other types of pedestrian accidents, if pedestrians or drivers do not obey the signals.

3D–9 Warrant 6, Combinations of Warrants

Signals may occasionally be justified where no one warrant is satisfied but two or more are satisfied to the extent of 80 percent or more of the stated values. These exceptional cases should be decided on the basis of a thorough analysis of facts.

Adequate trial of other remedial measures which cause less delay and inconvenience to traffic should precede installation of signals under this warrant.

3D–10 Selection of Type of Pretimed Control Mechanism

Where any of the previously described warrants is satisfied and the decision has been made to install a pretimed signal, it is necessary to select the type of pretimed control mechanism [14] to be used. The possible choices include the following, for which advantages are set forth in sections 3D–11 to 3D–13:

1. Nonsynchronous pretimed controller for isolated intersections.
2. Synchronous type of pretimed controller for isolated intersections.
3. Controllers providing for coordination.

3D–11 Nonsynchronous Pretimed Controllers for Isolated Intersections

This type of controller, which is timed by an electronic device, is not desirable and should be used only at unimportant isolated intersections warranting signalization where it is unlikely that there will be any need for coordination with other intersections as long as the controller is to be used.

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[14] *Pretimed, Fixed Cycle Traffic Signal Controllers*, Technical Report No. 2, Institute of Traffic Engineers.

By use of auxiliary devices, cycle lengths and proportions allotted to the various go intervals can be changed a limited number of times during the day. However, traffic-actuated or synchronous pretimed equipment is preferable where such changes are desirable.

3D–12 Synchronous Pretimed Controller for Isolated Intersections

This type of controller uses a synchronous timing motor and should be used at isolated intersections where:

1. In the future, the installation is likely to be coordinated with other signal installations or to be supervised by a master controller.
2. A fixed length of cycle and intervals will be tolerable during all hours of traffic control operation.

In some applications a two-dial or even a three-dial controller may be used to provide two or three timing schedules, giving the controller flexibility to accommodate some changes in traffic patterns. Selection of schedule can be accomplished by use of program devices.

3D–13 Controllers Providing for Coordination

Several types of control are available for coordination. One of these involves the use of synchronous motors without supervision from a master controller. Other systems involve supervision of local controllers by the master controller through wire interconnection or by radio. Local controllers in these systems may employ synchronous or induction motors or electronic timing devices. Sections 3D–17 to 3D–21 discuss the various degrees of flexibility attainable by different systems. The selection should be based upon:

1. The total volumes of traffic involved.
2. The relative amounts of and variation in traffic on the several approaches to the intersection.
3. The variation in directional flow on each street.
4. An analysis of the differences in costs in relation to expected benefits to the motoring public.

In general, the noninterconnected (or nonsupervised) synchronous system should not be used for very heavy traffic because of its limitations as to flexibility and because of the absence of assurance that the desired coordination will continue indefinitely.

However, in some cases, sufficient flexibility may be obtained by programing multiple-dial controllers at a few problem locations. Visual power-failure indicators attached to local controllers are desirable accessories for maintenance of coordination.

3D–14 Signal Timing in Accordance With Traffic Requirements

The full value of a signal installation is realized only when it is operated in a manner consistent with the traffic requirements. The use of unduly long cycles, or improper division of cycles of reasonable length, fosters disrespect for and poor observance of signal indications. Signals should not be operated manually more than is absolutely necessary, as this type of operation has frequently proved to be more inefficient than properly timed automatic control. This is particularly true of signals in a coordinated system.

One of the chief difficulties in signal timing comes from the need to accommodate two or three radically different volume patterns at various times during the period of operation. Any timing plan which is devised should be checked against the traffic-count information collected to be sure that the inevitable volume changes on the streets concerned will be handled in the best possible manner.

Some of the factors which must be considered in assigning green time to the intersecting streets are:

1. Number of traffic lanes and other physical conditions.
2. Volume of traffic in the critical lanes.
3. Requirements of commercial and public-transit vehicles.
4. Vehicle headways on the intersecting streets.
5. Pedestrian requirements.
6. Vehicle and pedestrian clearance requirements.
7. Turning movements.

Signal timing can become exceedingly complex when it involves not one but a series of signalized intersections which are to be operated so as to provide for continuous movement of platoons of vehicles. Varying block lengths often constitute a major difficulty in arriving at a satisfactory timing plan. There are many details involved in the development of efficient time-space diagrams for progressive signal systems and no attempt is made to present a full treatment of the subject in this Manual. The Traffic Engineering Handbook, published by the Institute of Traffic Engineers[15], contains a helpful discussion of the significant details of signal timing and describes a number of practical refinements possible in traffic signal systems. The Highway Capacity Manual[16], published by the United States Bureau of Public Roads, also provides useful information on the influence of traffic elements at intersections.

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[15] *Traffic Engineering Handbook*, second edition, 1950. Institute of Traffic Engineers, 2029 K Street, N.W., Washington 6, D.C.

3D-15 Division of Total Cycle Time

Reference has been made to the importance of assigning Go (green) time to the intersecting streets in accordance with the traffic demand. There follows a description of a method that has been employed successfully:

If, during the heaviest traffic hour, the effect of turning movements, slow-moving commercial vehicles, and other factors on the time spacing between vehicles in the critical lane leaving the intersection is equal for the two heavier traffic flows at right angles, the division of the total time cycle into the two Go periods will be approximately correct if these periods are made directly proportional to the intersecting volumes of traffic per critical lane. However, if, during the heaviest traffic hour, there is a considerable difference in the time spacing between vehicles in the two intersecting critical lanes because of, say, the presence of trucks and buses in one of the critical lanes and not in the other, this fact should be taken into account. In making the cycle division, the Go periods will be approximately correct if made proportional to the products of the critical lane volumes and the time spacings on the respective intersecting streets.

As a simple illustration, assume that a 60-second cycle has been selected and that the time required for vehicles to clear the intersection after the green signal is 5 seconds on each street. This leaves a total of 50 seconds of Go time to be divided between the two streets. Assume that the critical lane volumes V_A and V_B on streets A and B during the heaviest traffic hour are 400 and 250 vehicles, respectively. In the first case, assume that the time spacing between vehicles, or headway on departure, for each of the two streets is the same. The Go time assigned to each street, T_A and T_B, would then be approximated as follows:

$$\frac{T_A}{T_B}=\frac{V_A}{V_B}=\frac{400}{250} \quad \text{.......} \quad (1)$$

$$\text{and } T_A+T_B=50 \text{ seconds (total Go time)} \quad \text{.......} \quad (2)$$

Solving for T_B in (2) and substituting in (1):

$\frac{T_A}{50-T_A}=\frac{400}{250}$, whence $T_A=31$ seconds.

From (2), $T_B=50-31=19$ seconds.

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[16] *Highway Capacity Manual*, 1950. Bureau of Public Roads, Washington, D.C.

In the second case, assume that the time spacing between vehicles, or departure headway, H_A and H_B, is 3 seconds on street A and 5 seconds on street B. This difference in headway might be caused by a sizable percentage of trucks in the critical lane on street B. The division of the Go time would then be approximated as follows:

$$\frac{T_A}{T_B}=\frac{V_A\times H_A}{V_B\times H_B}=\frac{400\times3}{250\times5} \tag{3}$$

Solving for T_B in (2), and substituting in (3):

$\frac{T_A}{50-T_A}=\frac{400\times3}{250\times5}$, whence $T_A=24$ seconds.

From (2), $T_B=50-24=26$ seconds.

It should be emphasized that such elementary calculations provide only an approximate means of determining the proper time for each street. Other considerations, such as the time required for pedestrian crossings and physical conditions at the intersection, also affect signal timing. After the initial selection of a cycle length and a timing program, frequent checkbacks and studies of the signal in operation should be made to obtain the most efficient timing schedule.

As a general principle of traffic signal timing, no vehicle Go interval should be less than the time required for the waiting group of pedestrians to get started and to cross to a point of safety unless an exclusive pedestrian interval is also employed. Experiments with signal timing have shown that, insofar as vehicle movements are concerned, excellent efficiency can be attained under certain offpeak conditions with Go intervals as short as 15 seconds. Ordinarily, however, they must be somewhat longer to give the pedestrian a safe opportunity for crossing the roadway.

When the pedestrian crossing time runs concurrently with the vehicle Go period, which is the usual case, the total Go interval should be long enough to allow not less than 5 seconds during which it is indicated that pedestrians may start to cross, and enough longer to permit pedestrians who have entered the roadway to reach a place of safety with the additional time provided by the vehicular clearance interval. Thus if it takes 14 seconds for most pedestrians to cross the roadway or reach a point of safety, and if the vehicle clearance (yellow) interval is 3 seconds, the total Go (green) interval should be at least $5+14-3$, or 16 seconds.

3D–16 Coordination of Pretimed Signals

In general, all pretimed signals within one quarter of a mile of one another and controlling the same traffic should be operated in coordination. Even at greater distances coordination may be desirable under certain conditions.

Great inconvenience and delay result from independent, non-interrelated operation of closely adjacent signal installations operating on pretimed control. Most of this delay can be eliminated by carefully planned coordination. However, under certain adverse conditions which seriously affect the efficiency of coordinated control, greater efficiency may be possible with traffic-actuated control, operated either independently or in combination with coordinated control (sec. 3E–8).

For required coordination with railroad grade-crossing signals, see section 3B–25.

3D–17 Types and Selection of Coordination

The most useful classification of traffic control signal systems is based on their method of coordination. Since the primary purpose of this coordination is to organize and facilitate traffic flow, it is essential to understand what vehicular traffic will do under the various systems. On this basis of classification there are four general types of coordination of pretimed signals. These are defined as the simultaneous system, the alternate system, the limited progressive system, and the flexible progressive system (secs. 3D–18 to 21).

3D–18 Simultaneous System

In a simultaneous system all signals show the same indication to the same highway at essentially the same time. This is one of the early types of signal systems and it has limited but important applications in modern traffic signal practice.

At all intersections the timing is essentially the same and indications change simultaneously or nearly so to show green at each signal facing the major-street traffic and red to all minor streets, and similarly throughout the cycle.

At normal traffic speeds the time required to travel between closely spaced intersections is so short that a very short cycle would be required for a flexible progressive or alternate system of control. If only two such intersections are to be coordinated, the best plan is generally to operate them as a simultaneous system, giving an ample green interval on the major street for a major portion of the traffic to clear through both intersections. If two such close intersections are encountered in a larger group to be coordinated, the best plan is to select the flexible progressive system and to adjust the offsets at the two closely adjacent intersections so as to interfere the least with the continuous movement of traffic. Frequently this will result in virtually simultaneous operation of these two signal installations.

Under conditions of heavy traffic, progressive signal systems may break down because of the accumulation of vehicles between signals. Under these conditions a simultaneous system may substantially improve operation of traffic in the system.

The simultaneous stopping of all traffic along the highway prevents continuous movement of vehicles and, particularly during low-volume periods, may result in high speed between stops but low overall speed. Also, cycle length and interval proportioning are usually controlled by the requirements of one or two major intersections in the system. This may result in serious inefficiencies at the remaining intersections.

3D–19 Alternate System

In the alternate system adjacent signals or groups of signals show opposite indications alternately along a given highway. In the single-alternate system opposite indications are shown by adjacent signals. Double- and triple-alternate systems consist of groups of two or three signals respectively showing opposite indications. The alternate system is usually an improvement over the simultaneous system in that throughout a series of intersections so controlled there can be, under favorable conditions, continuous movement of groups of vehicles at a predetermined speed, this being most efficient where the lengths of the blocks, or of the alternating groups of blocks, are equal and adequate. Alternate systems are exemplified by a one-half-cycle offset or advance start of green between adjacent signalized intersections.

An alternate system can be operated with a single controller, but this arrangement is not recommended, mainly because of the increased flexibility obtainable with local intersection controllers.

3D–20 Limited Progressive System

In the limited progressive system a fixed common time-cycle length is used and green indications are proportioned to conform with requirements of each intersection and are given independently in accordance with a timing schedule designed to permit continuous or nearly continuous movement of groups of vehicles along the highway at a planned rate of speed.

Supervision of a limited progressive system by a master controller through wire interconnection or by means of signals transmitted by radio may be used to maintain proper timing relations (offsets) between signals. Or synchronous-motor-driven controllers operated by a common or electrically synchronized source can be employed without interconnection or remote supervision by master control. However, power failures, severe dips in voltage, and variations in temperature may cause individual local controllers to fall out of step and disrupt planned movement of vehicles. In order to assure satisfactory operation periodic patrol of such systems is necessary. Visual power-failure indicators expedite detection of controllers not operating on the desired schedule.

3D–21 Flexible Progressive System

The flexible progressive system incorporates all features of a limited progressive system and has a number of additional features, depending on the type of intersection controller, master controller, and appurtenances selected. A common time cycle is used throughout the system. However, the length of the cycle can be changed as frequently as desired.

Through use of modern multiple-dial intersection controllers it is possible to establish several schedules for division of the cycle. In addition, it is possible to change offsets as frequently as desired. Predetermined timing programs can be set up on multidial controllers to favor rush-hour traffic movements at appropriate times during the day or week, offpeak traffic demands, and other traffic conditions. With this flexibility it is possible to meet efficiently the varying demands of traffic at each intersection and in the system.

Synchronous timing motors operated from a variable-frequency power source can give several different cycle lengths, and the number of possible timing schedules can be expanded accordingly.

Supervision of intersection controllers can be accomplished by direct wire interconnection from a master controller, by means of radio signals transmitted from a master control station, or by leased telephone lines. Wire interconnection can involve use of multiple conductor cables with one conductor assigned to each program function in addition to a common ground conductor.

An alternate type of wire interconnection involves use of two-conductor circuits carrying coded tone pulses from the master controller which are converted by a decoding device at the intersection controller into signals which select the desired timing schedule. Systems involving use of radio for coordinating traffic signals are similar to the two-conductor wire system except that tone pulses are transmitted and received by radio instead of by wire. Transmitting equipment and operators must be licensed by the Federal Communications Commission.

In any flexible progressive system knowledge of demands of traffic must be available in order to select appropriate timing schedules. Counts of traffic and measurements of vehicle speeds are essential to determine proper cycle lengths, cycle division, and offsets. In order to take full advantage of flexibility, measurements of traffic should be made frequently. In general, a properly designed and operated flexible progressive system is the pretimed system best adapted to efficient movement of traffic. Its advantages include the following:

1. With adequate highway capacity and favorable signal spacing, continuous movement of entire groups of vehicles is possible with a minimum of delay and at an average speed planned for the system.
2. A high degree of efficiency results from proportioning Go periods to fit traffic requirements at each intersection.
3. More uniform speeds are encouraged.
4. Differences in block lengths are better handled than with other pretimed systems.

3D–22 Conditions Affecting Efficiency of Signal Systems

Certain conditions seriously reduce the efficiency of signal systems, even of the best flexible progressive systems. Among these are:

1. Very short signal spacing (this particular condition does not affect the simultaneous system).
2. Inadequate highway capacity and interferences from parking and loading operations.
3. Traffic composed of units of widely differing speeds, such as streetcars, buses, trucks, and passenger automobiles, especially on narrow streets.
4. Certain types of complicated intersections, such as those requiring three or more phases per cycle.
5. Heavy volumes of vehicles turning from or into the artery, especially if the block into which they turn is short or otherwise limited in capacity.
6. Exclusive pedestrian intervals.

3D–23 Manual Control

At heavily traveled intersections operating under isolated control, manual operation of signals at certain times may be warranted by varying traffic requirements. The provision of apparatus to permit manual operation of signal installations in a flexible progressive system, however, is not generally recommended.

Experience has shown that if manual-control features are available a tendency on the part of the police to operate certain intersections manually is likely to develop. This often destroys coordination at those intersections and through the system, with disadvantages generally more important than the possible improvement achieved by proportioning intervals manually. The presumption should be strongly against manual control in coordinated systems until the inability of automatic control to meet the situation at the particular intersection is proved.

3D–24 Speeds for Progressive Systems

A speed or speeds for which a flexible progressive system is designed should accord reasonably with what speed studies show would be the speed of vehicle movement if cross-traffic delays were eliminated. After drivers have become accustomed to a progressive system it may be possible to increase the speed with safety.

High speeds should be avoided, especially in busy urban districts. Progressive systems along urban arteries are generally timed for speeds ranging from 20 to 30 miles per hour, although in outlying areas, under favorable circumstances, higher system speeds may be desirable. In general, the more heavily used the artery, the narrower the roadway, the more built-up and busy the district, the shorter the blocks controlled, the more mixed the types of traffic, or the more pedestrian and cross-street traffic there is, the lower should be the design speeds.

The relationship between signal-system design speeds and official regulations governing speeds must also be given careful attention.

3D–25 Signs Indicating Timed Speed

Traffic signal speed signs may be erected to guide drivers if the speed for which traffic signals are set is substantially lower than speed limits in effect on streets in the signal system.

When signs specified in section 1C–37 are used, they shall be posted as near as possible to traffic signals and at such intervals as are necessary to inform traffic properly.

E—TRAFFIC-ACTUATED SIGNALS

Section 3E–1 Definition

A traffic-actuated signal is a type of traffic control signal in which the operation is varied in accordance with the demands of traffic as registered by the actuation of vehicle or pedestrian detectors. Traffic-actuated signals can be classified in three general categories:

Semi-traffic-actuated signal.—A type of signal in which means are provided for traffic actuation on one or more but not all of the approaches to the intersection.

Full traffic-actuated signal.—A type of signal in which means are provided for traffic actuation on all approaches to the intersection.

Traffic-adjusted signal.—A type of signal in which characteristics of signal display at local controllers in an area or for an artery are continuously varied in accordance with the receipt of traffic flow information supplied to a computing master control by sampling detectors located at typical flow points in the area.

3E–2 Factors Governing Selection of Type of Control

In each of these categories there are several different types, and cases to which they are especially applicable (secs. 3E–5, 3E–6 and 3E–7, respectively). In addition, there are special applications such as pedestrian actuation, one-way restricted zone control (sec. 3B–26), and others.

The variety of types and applications of traffic-actuated control available makes it essential that a thorough knowledge of traffic and physical facts be obtained prior to selecting equipment for installation.

In some instances traffic-actuated equipment has been installed primarily for the purpose of speed control, either in conjunction with intersection control or for midblock locations. Traffic signals are not particularly effective in speed-control applications and the use of traffic-actuated equipment for this purpose is accordingly not recommended.

3E–3 Warrants for Intersection Control

When the installation of pretimed signals is warranted, consideration should also be given to the use of traffic-actuated signals. However, because traffic-actuated signals at intersections are responsive to rapid fluctuations in traffic conditions and do not normally delay traffic unnecessarily, it is not advisable to set values of minimum traffic volumes or other fixed warrants for their installation. There are a number of factors that should be considered and weighed before selecting and installing such signals:

Vehicular volumes.—At intersections where the volume of vehicular traffic is not great enough to warrant pretimed signals, traffic-actuated signals may be applied if other conditions indicate the need for traffic control signals and justify the cost of the installation.

Cross traffic.—When the volume of traffic on the major street is so great as to restrict and jeopardize unduly the occasional movement of vehicular or pedestrian cross traffic on the minor street, semi-traffic-actuated signals may be installed to provide for assignment of right-of-way to the minor movement. However, the movement of major-street traffic may be unduly and unnecessarily interrupted if traffic on the minor street is heavy enough to call for the right-of-way at frequent intervals. In such cases it may be necessary to limit the amount of green time for the minor street (sec. 3E–5).

Peak-hour volumes.—When traffic control signals are required at an intersection during only a small part of the day, such as during peak traffic hours, traffic-actuated signals may be installed if economically justified, since they will not unduly delay traffic at other times.

Pedestrian Traffic.—When only the minimum pedestrian volume warrants (sec. 3D–6) for pretimed signals are met, traffic-actuated signals should be considered. They will delay vehicular movements only when the streets are in use by pedestrians.

Accident hazard.—When only the minimum accident-experience warrant (sec. 3D–8) for pretimed signals is met, use of traffic-actuated signals should be given consideration, as they may lessen the stops and delays which are commonly associated with accidents after signalization. Traffic-actuated signals may be economically justified at locations where the accident experience is less than that warranting pretimed signals, but careful analysis should be made to assure effective results.

Wide traffic fluctuations between streets.—When the relative volumes of traffic on the entering streets fluctuate widely at an intersection where pretimed signals are warranted, full traffic-actuated control will usually provide the greater efficiency in intersection operation.

Complicated intersections.—When traffic signals are warranted at complicated intersections requiring multiple traffic phases, use of traffic-actuated signals should be given consideration because, in addition to the usual advantages of traffic actuation, a phase can be skipped when there is no traffic to use it.

Progressive signal systems.—When the spacing or character of an intersection in a pretimed progressive signal system is such that satisfactory progressive timing cannot be achieved, traffic-actuated control can be employed to advantage (sec. 3E–8).

3E–4 Warrants for Nonintersection Control

Special conditions at roadway locations other than intersections may warrant the installation of traffic-actuated signals. Some of the factors that may justify such installations are:

One-way restricted zones.—At locations on two-way roadways where traffic can move in only one direction at a time, such as at narrow bridges and tunnels, or on construction projects, traffic-actuated signals can be used effectively. (sec. 3B–26)

Nonintersectional pedestrian crossings.—Pedestrian crossings concentrated at schools or other major pedestrian crossings where intersections are a considerable distance apart may justify use of pedestrian-actuated signals (sec. 3D–6).

The installation of signals between intersections for the purposes indicated above should be accompanied by the erection of appropriate signs advising the motorists of this special application. Immediately subsequent to installation there should be a period of strict enforcement so that disrespect for signal indications will not develop.

3E–5 Semi-Traffic-Actuated Control

Semi-traffic-actuated control is applicable primarily to an intersection of a heavy-volume, high-speed traffic artery with a relatively lightly traveled minor road or street. Detectors are located only on the minor approaches. The signal is normally green on the major street, changing to the minor street only as a result of vehicle or pedestrian actuation thereon. In some types of controls the minor-street green interval is of fixed duration, which is undesirable. In the more flexible types the duration of the minor-street green interval is proportioned to the traffic demand thereon, with provision for a maximum limit beyond which the green light cannot be retained on the minor street even when traffic demand thereon is heavy. Upon the expiration of the required or maximum minor-street phase, the green indication reverts to the major street, where it must remain for at least a predetermined minimum interval. At the expiration of this minimum interval the control is again free to respond to minor-street actuation. The semi-traffic-actuated control mechanism receives no actuation from traffic on the major street, and therefore may frequently assign the right-of-way to the minor street at the most inopportune times for major-street traffic. Hence the effective use of semi-traffic-actuated control is limited to intersections with very lightly traveled minor streets and to intersections in coordinated systems where major-street progression can be assured by means of a background cycle (sec. 3E–8).

3E–6 Full Traffic-Actuated Control

Semi-traffic-actuated control does not detect and measure the demands of all traffic streams, and full traffic-actuated control therefore should be selected for intersections where failure to take all demands into account will materially impair the efficiency of traffic movement. In full traffic-actuated control, detectors are installed on all approaches to the intersection. Right-of-way is assigned to a street only as a result of one or more actuations on that street. When there is no traffic on any street, the green indication will ordinarily remain upon the street to which it was last assigned, but when one street carries substantially more traffic it may be more efficient to return the right-of-way to that street. In the event of continued actuation on one street, transfer of right-of-way will be made to waiting cross traffic upon the expiration of a predetermined maximum period, and then automatically return to the first street at the earliest opportunity. This opportunity cannot arise until a predetermined minimum green period on the cross street has expired.

The duration of the green indication for each street under normal traffic will fluctuate between the prescribed minimum and maximum values, depending upon the length of time between actuations on the street having the right-of-way. Under the more common type of full traffic-actuated control, the right-of-way will, upon actuations, be immediately transferred to the cross street if the length of time between actuations on the street having the green exceeds a predetermined value, and the minimum period for that street has expired. Hence the right-of-way is switched from street to street depending upon the frequency of gaps in traffic which exceed in length the predetermined time values for each street. With heavy traffic such gaps are relatively infrequent and the green periods are extended to their maximums. Under this condition traffic-actuated signal operation approaches that of pretimed signals.

The traffic-density type of full traffic-actuated control provides that the predetermined gap interval described above will diminish during each phase depending upon a number of traffic factors. Thus the probability that the green period will be terminated and the right-of-way transferred to the other street is increased by a thinning out of traffic moving on the green signal, by the passage of time during which traffic has been waiting on the red signal, and by the number of cars waiting on the red signal. These and other factors make the traffic-density full traffic-actuated control highly sensitive to traffic requirements under wide ranges of traffic volumes.

Full traffic-actuated control of either type can be applied to more than two-phase operations. Equipment is available for three- and four-phase intersections. Operation of controllers at such intersections is similar in principle to operation at two-phase intersections. Opportunity for the right-of-way is accorded to the several phases in rotation and phases for which there is no traffic demand are skipped. In three- or four-phase controls, provision can be made for allowing additional noninterfering traffic flows to move during more than one phase. Thus a three-phase control may handle four or five flows, provided only three of them are commonly interfering. Pedestrian actuation should be provided where necessary to assure a minimum green period of sufficient length for pedestrians or to establish pedestrian intervals (secs. 3E–9, 3F–7).

3E–7 Traffic-Adjusted Control

A combination of the advantages of a pretimed flexible progressive signal system and traffic-actuation can be realized by a system in which a traffic-actuated master controller is used to supervise either pretimed or semi-traffic-actuated local controllers. Detectors are placed at representative locations in the progressive system to provide the master controller with information concerning the traffic at those points. The master controller selects the cycle and offset combination predetermined to serve best the directional balance and volume characteristics existing at that time. The local controllers are connected to the master controller and operate at any given moment upon the cycle and offset selected by the master controller.

With traffic-adjusted control, transfer from one timing combination to another takes place quickly and with minimum interference to traffic moving during the changeover. If local controllers are semi-traffic-actuated, the duration of the minor-street phase within the selected cycle length is determined by actuations from detectors installed on the minor street. This system provides a wide degree of flexibility for effective coordination of traffic movements, either along a thoroughfare or in a network of streets.

3E–8 Other Coordinated Control

In addition to traffic-adjusted control there are other applications of traffic-actuated equipment in coordinated operation of a series of related signalized intersections, as follows:

Supervisory background cycle.—A supervisory background cycle can be imposed upon a series of semi-traffic-actuated controls by a master timer sending out impulses to each semi-actuated controller, or by local synchronous-motor control at each intersection.

The background cycle and offsets are determined in the same manner as for pretimed control to give the maximum travel band through the area. The function of the supervisory cycle is to assure that the local semi-traffic-actuated controllers provide at least the minimum main-street green interval in a time relation best suited to main-street progression. Each semi-traffic-actuated controller adds to its main-street green interval all time not required by traffic-actuated demand on the minor street, thereby providing the widest possible travel band. One possible disadvantage is that such an extended main-street green interval may seriously overload a subsequent intersection at which cross-traffic requirements are greater.

The type of operation just described obviously does not have the same speed-control characteristics as a pretimed progressive system, and hence should be used only where the consideration of moving maximum amounts of traffic with the least delay outweighs the considerations of speed control.

Special use in a pretimed progressive system.—A further application of traffic actuation in the field of coordinated movement occurs in a pretimed progressive system where intersection spacing at one or more points in the system is such that the best progressive timing arrangement involves considerable reduction or displacement in the travel band. Complicated intersections in a progressive system may also cause difficulties in the progressive timing. In these instances traffic-actuated control can sometimes be effectively employed to reduce the ill effects.

Mutual Coordination.—Mutual coordination is the coordination of two isolated semi-traffic-actuated controllers located at adjacent or nearby intersections in such a way as to minimize the stopping of traffic on the main artery. This is done by interconnecting the controllers so that there is a fixed offset between side street actuations.

3E–9. Pedestrian-Actuated Control

Operation of traffic-actuated signals must take into consideration the needs of pedestrian as well as vehicle traffic. This can be accomplished in the following ways:

1. When pedestrian signals are not warranted in conjunction with a traffic-actuated signal installation (sec. 3F–2) but where occasional pedestrian movement exists and there is inadequate opportunity to cross without undue delay, pedestrian detectors shall be installed. The pedestrian actuations may be handled on the same basis as vehicle actuations, provided that the minimum green interval is adequate to serve pedestrians. In this case, no separate pedestrian signal indications are shown.

2. When pedestrian signals are not otherwise warranted but a pedestrian movement exists which would not have adequate crossing time with the above operation (sec. 3F–2 paragraph 7), pedestrian signals and detectors shall be installed and operated as prescribed in section 3F–7.

3. When pedestrian signals are warranted and installed in conjunction with a traffic-actuated signal, the operation should follow the patterns described in section 3F–7.

3E–10 Detectors and Controllers

The traffic-actuated signal, as its name implies, responds to vehicle or pedestrian actuations, and it is necessary that detector and controller equipment be designed for this service. In this respect traffic-actuated signals differ considerably from pretimed signals, which require no detector units and a somewhat simpler timing mechanism for their control. The general characteristics of the various types of detectors and controls that have been developed for use with traffic-actuated equipment are described below. More comprehensive descriptions and specifications are contained in standards adopted and published by the Institute of Traffic Engineers.[17]

3E–11 Types of Detectors

Four types of detectors are in common current use:

1. Pressure-sensitive detectors.
2. Magnetic detectors.
3. Radar detectors.
4. Pedestrian push-button detectors.

Other types have been used to a limited degree or are in stages of development, including:

5. Light-sensitive detectors.
6. Sound-sensitive detectors.
7. Infrared-ray-sensitive detectors.
8. Ultrasonic-sound-sensitive detectors.
9. Pneumatic detectors.

Each type has its advantages and disadvantages, and the selection should be made only after appraisal of physical and traffic conditions at the intersection.

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[17] *Traffic Actuated Traffic Controllers and Detectors,* Technical Report Number 3, Institute of Traffic Engineers, 1958.

3E–12 Pressure-Sensitive Detectors

A pressure-sensitive detector is installed in the roadway and is operated by the pressure of vehicle wheels passing over its surface. In general it may be thought of as an electric switch which is closed by the pressure of a vehicle wheel. It is capable of actuation by vehicles traveling at speeds up to 60 m.p.h. but is rendered inoperative if a car is stopped upon it. The detector is embedded in the pavement with the switch unit designed for removal and renewal as necessary. There are two types of such detectors:

Nondirectional detectors.—The detector is operated by traffic moving over its surface in either direction and has a single electrical contact.

Directional detectors.—The detector is operated by traffic moving over its surface in only one direction. Outwardly similar in appearance to the nondirectional detector, it has two sets of electrical contacts which are closed sequentially by vehicle passage and which operate into a special relay unit in the controller cabinet. This type of detector with its relay unit should be used whenever a detector may be subject to actuation by vehicles moving away from the intersection. It is less sensitive to high-speed vehicles than the nondirectional detector.

3E–13 Magnetic Detectors

Magnetic detectors are actuated by the disturbance of an electrical field caused by the passage of a vehicle, and are of two general types, noncompensated and compensated. Both types respond only to moving vehicles and are consequently not rendered inoperative or continuously operative by parked cars or other fixed metal objects within their zone of influence. Both types require auxiliary units to amplify the very small voltage generated in their coils by the passage of a vehicle.

Noncompensated detectors.—These detectors are usually installed in fiber conduit under the roadway surface and have an adjustable zone of influence up to 10 feet beyond either end of the detector. As the distance from the detector increases the sensitivity to slow-moving vehicles decreases, so that at maximum range only vehicles traveling at more than 12 m.p.h. are detected. Noncompensated detectors are not recommended for locations where a sharp cutoff is essential or where they are subject to external electromagnetic influences such as are caused by trolley buses and power lines.

Compensated detectors.—Detectors of this type involve two magnetic circuits and are so designed that their operation is not affected by extraneous electromagnetic influences. They are constructed for installation in the roadway pavement and are characterized by a relatively sharp definition of their zone of influence, usually extending only about 6 inches beyond each end of the detector. The best detectors of this type are capable of a high degree of directional discrimination and can, therefore, be used effectively on narrow streets.

3E–14 Radar Detectors

The radar detector is designed for mounting over the roadway and is actuated by the passage of a vehicle through its field of emitted microwave energy. It has limited directional characteristics, and is responsive only to vehicles moving at more than 2 m.p.h. It is not affected by parked vehicles or ordinary external electromagnetic influences. Its amplifying units and relays are self-contained. It has an adjustable zone of transverse influence of from 9 to 30 feet at normal mounting height.

3E–15 Pedestrian Push-Button Detectors

In addition to detectors for registering the demand of vehicles approaching an intersection, it is in many instances necessary that means be provided for registering pedestrian traffic demand. Pedestrian push buttons are used for this purpose and are properly regarded as a form of detector. In order to be suitable for traffic-actuation purposes, a push button must be designed to withstand rigorous service (sec. 3E–25).

3E–16 Adjustment Features of Traffic-Actuated Controllers

Traffic-actuated controllers must have a number of functional adjustments of sufficient range to provide the flexibility necessary to meet wide and sometimes rapid variations in traffic conditions at an intersection.

In semi-traffic-actuated control, the green interval is normally accorded to the major street, being called to the minor street upon actuation. The green interval for the minor street may be set for a given duration or may have the same initial portion and extensions described in the following paragraph for full traffic-actuated control. The major street does not have actuation, and its minimum green interval is determined by a minimum-period adjustment. At the end of this minimum period the green indication can again be transferred to the minor street in response to actuation. The major-street minimum period should therefore be set with due regard to expected major-street traffic conditions.

In full traffic-actuated control the green intervals for all approaches have an initial period to permit standing traffic to get into motion, followed by one or more unit extensions, as determined by the traffic demand. In the event of continued demand on an approach, with demand on the other street, the green phase is terminated by the operation of the extension limit. Vehicle-clearance intervals are provided at the end of every green interval. For each phase there is a recall switch, making it possible to require the green to return to that phase in the absence of actuations. With all recall switches on, the controller will in the absence of any actuations act as a pretimed control.

All of the features mentioned in this section should be readily adjustable by calibrated knobs, pins, or dials.

3E–17 Range of Adjustments for Semi- and Full Traffic-Actuated Control

The range of timing adjustments indicated in table 5 will cover normal operating conditions for semi-traffic-actuated and full traffic-actuated signal control. Timing adjustments should be on the basis of operating conditions at the intersection and should be periodically checked against actual performance.

Table 5.—Range of adjustments for semi- and full traffic-actuated control

	Range of timing adjustments	
	Semi-traffic-actuated	Full traffic-actuated
	Seconds	*Seconds*
Major-street minimum period	10–90	
Major-street initial period		2–30.
Minor-street initial period	2–12	2–30.
Major-street unit extension		2–30.
Minor-street unit extension	2–12	2–30.
Major-street extension limit		10–60.
Minor-street extension limit	10–60	10–60.
Vehicle clearance intervals[1]	Up to 10	Up to 10.
Pedestrian walk intervals[2]	5–35	3–35.
Pedestrian clearance intervals[2]	Up to 15	Up to 15.
Recall switches		ON-OFF.

[1] A range beyond the recommended maximum yellow clearance interval is provided to permit use of all-red clearance intervals (sec. 3B–23).

[2] If included.

3E–18 Range of Adjustments for Traffic-Density Control

The foregoing description of adjustments does not include those for traffic-density types of traffic-actuated controllers. Properly installed, adjusted, and maintained controllers of this latter type take account of a number of varying factors in their assignment of right-of-way. Included are the number of vehicles arriving against the red light, their waiting time, and the headway of vehicles moving on the green light. Adjustment of the minimum green time is automatically made with respect to the number of vehicles accumulated between the detector and the Stop line prior to the green interval. Some forms of controllers are capable of operation to facilitate platoon movement. All forms of traffic-density controllers are provided with specialized timing adjustments required for their operation. Adjustments for each phase of a typical two-movement controller of this class are indicated below:

		Range
Minimum green portions	seconds	5–60
Number of actuations before minimum green portion starts to increase	actuations	5–35
Added green portion for each actuation	seconds	1–20
Passage time from detector to Stop line	do	5–15
Allowed gap between actuations which is affected by waiting time of cars on other phase	do	10–1
Waiting time which affects above gap	do	10–90
Allowed gap between actuations which is affected by number of cars waiting on other phase	do	10–1
Number of waiting cars which affects above gap	cars	10–75
Allowed gap between actuations which is affected by headway of moving cars	seconds	10–1
Number of actuations per 10 seconds which affects above gap	actuations	10–75
Platoon carry-over effect	percent	10–90
Extension limit	seconds	10–90
Clearance interval [1]	do	up to 10
Recall switch		ON-OFF

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[1] A range beyond the recommended maximum yellow clearance interval is provided to permit use of all-red clearance intervals (sec. 3B–23).

3E–19 Special Controller Equipment

The normal adjustment features of a traffic-actuated controller may not always be adequate to provide necessary or desirable features for special conditions. In some cases these features may be added internally and in others an auxiliary controller or timer is used. Some conditions of this character are as follows:

1. Necessity for pedestrian WALK and clearance intervals when pedestrian signals are included.
2. Necessity for an all-red clearance interval following the normal yellow vehicle clearance interval as might be required at unusually large or irregular intersections, or in one-way restricted zones.

3. Desirability of utilizing an alternate phasing with certain combinations of actuations. Such a situation occurs where nonconflicting left turns move during the same phase and all other traffic is stopped. When one of these turning movements is not present, however, it is possible to permit the movement of through traffic with which it would conflict. This can be accomplished with an auxiliary-movement controller, or special overlap relays.

4. Desirability of rendering certain detectors inoperative during some phases. In the above case, the through traffic is permitted to move during the left-turn phase only because of the absence of opposing left-turn traffic in that cycle. Unless the through-traffic detectors concerned are made inoperative during the left-turn phase, their actuations would falsely affect the relative time assigned to the through-traffic phase.

5. Provision for interconnection when a traffic-actuated signal is located within a pretimed progressive system (sec. 3E–8).

6. Provision for emergency features as might be required in conjunction with railroad crossings, emergency vehicles, civil defense, etc. (secs. 3B–25, 3B–27).

3E–20 Installation of Traffic-Actuated Signals

The installation of signal heads and controllers and of traffic-actuated signals involves the same considerations as those described in Sections 3B–1 to 33, which are applicable to all types of signals. However, since adjustments of the various control settings are frequently made in the field, it is particularly desirable to position the controller with a clear view of the approaches and with the controller cabinet door away from the intersection.

Details of the location and installation of vehicle detectors (secs. 3E–21 to 24) deserve special explanation because of their importance to the efficient and reliable operation of traffic-actuated signal equipment.

3E–21 Location of Vehicle Detectors for Semi- and Full-Traffic-Actuated Control

The placement of vehicle detectors in relation to the Stop line should be determined only after careful study and consideration of a number of factors, including type and operating characteristics of the controller, approach speed of vehicles, grade and width of the roadway, visibility, driveways, and channelized turning lanes. With conventional full and semi-traffic-actuated controller equipment under average conditions, table 6 will provide a basic guide subject to considerations discussed below.

The distances shown in table 6 are for a one- or two-lane approach at a level grade. With a wider roadway and with unrestricted visibility these distances may be increased if desired by 10 to 15 percent.

Where an intersection includes a channelized approach and separate turning lanes, certain detector spacings may have to be relatively short, due to limitations imposed by the length of the turning lane, the lower speeds of turning vehicles, and the need to avoid false actuations.

Table 6.—Placement of detectors in relation to other factors

85-percentile speed of approaching traffic	Distance from Stop line	Approximate minimum initial period[1]	Approximate minimum unit extension[1]
M.p.h.	*Feet*	*Seconds*	*Seconds*
Less than 20	110	11	4
20-30	140	15	4
30-40	170	18	4
Over 40	210 or more	23	4

[1] The sum of the initial period and one unit extension is the minimum green period displayed.

The last two columns in table 6 indicate the approximate minimum dial settings that should be used for the various detector-to-Stop-line distances. These minimum values will insure that vehicles actuating a detector get a green indication until the maximum limit for green time on that approach has been reached. A short spacing permits use of lower values for these settings, which result in quick responding control. A longer spacing, on the other hand, permits the controller to react to a vehicle farther away, and sometimes avoids an unnecessary stop by providing or extending the green period before the vehicle reaches the stop line.

3E–22 Locating Vehicle Detectors Near Commercial Driveways

If commercial driveways exist not too far from the normal detector locations, it is frequently possible to obtain satisfactory results by departing somewhat from the distances given above. However, if the driveway is relatively close to the Stop line, it is advisable to install a special detector which will be traversed by a vehicle leaving the driveway. This detector should be a "calling detector" which operates only during the red phase. This arrangement permits the controller to function normally on the "running" detector, yet still assures that driveway traffic can call the right-of-way if no other traffic is present. Due to the extremely light traffic using driveways of single-family residences, special detectors are usually not provided for them.

3E–23 Location of Vehicle Detectors for Traffic-Density Control

For traffic-density type controllers, it is essential that relatively long distances be used between detector and Stop line, since these controllers derive much of their efficiency from their ability to receive information on approaching traffic as early as possible. For normal roadway and traffic conditions, the distances shown in table 7 have been found satisfactory.

Where the greatest platoon-movement effect is desired, the detector spacings on that street should be increased about 20 percent.

3E–24 Location of Vehicle Detectors from Centerline

Pressure-sensitive and compensated magnetic detectors should be placed transversely in the roadway so that all vehicles approaching the intersection will cross them with one or more wheels.

The pressure-sensitive detector nearest the centerline of the road should be located with its end about 3 feet from the centerline. If it is impossible to do so and still avoid unwanted actuations by some cars moving away from the intersection, a directional detector should be used (pressure-sensitive, compensated magnetic, or ultrasonic). On multilane approaches or one-way streets it is ordinarily necessary that a detector be placed in each lane, with no more than a 4-foot gap between detectors. It should be noted that volume-density controllers can in some cases be operated effectively with detectors only in selected lanes on each approach.

Transverse placement of the compensated magnetic detector is approximately the same as for the pressure-sensitive detector, bearing in mind that the former has a cutoff point that extends about 6 inches out from each end.

Table 7.—Placement of detectors for traffic-density control

85-percentile speed of approaching traffic	Distance from Stop line
M.p.h.	*Feet*
20–30	240.
30–40	270.
40–50	320.
Over 50	375 or more.

The noncompensated magnetic detector, when adjusted for maximum coverage, does not have a sharp cutoff point. Unless very wide coverage is desired, the recommended location is 6 to 12 inches beneath the pavement, under the path normally traveled by the right wheels of the vehicle. This type of detector is not well adapted to a situation where detection must be restricted to one lane.

The radar detector may be mounted from the minimum height allowed by law for overhead clearances (frequently 14½ feet) to a maximum of about 17 feet. When sharp definition is required, the minimum possible height above grade should be used.

3E–25 Installation of Pedestrian Detectors

Pedestrian detectors of push-button or other types shall be designed to operate on a circuit not to exceed 18 volts. They may be mounted on signal standards, wood or steel poles, or individual posts. They should be conveniently located near each end of crosswalks used to cross the intersection. A mounting height of 3½ to 4 feet above the sidewalk has been found best adapted to general usage. Permanent-type signs (sec. 1B–36) should be mounted above or in unit with the detectors, explaining their purpose and use. Where two crosswalks, oriented in different directions, end at or near the same location, the positioning of pedestrian push buttons should clearly indicate which crosswalk is actuated by each push button.

Special-purpose push buttons to be operated only by authorized persons should include a housing capable of being locked to prevent access by the general public. Instruction signs are not necessary in this case.

3E–26 Operation and Characteristics of Traffic-Actuated Signals

With all types of traffic signals it is necessary that appropriate equipment be installed to meet traffic requirements at a given location. Assuming the availability of such equipment, it is still necessary to adjust and operate the equipment as nearly as possible in accordance with the needs of traffic.

Continuing adjustment in the operation of traffic-actuated equipment is essential to efficient traffic control because of the numerous timing intervals and adjustment features which are instantaneously sensitive to traffic actuation. Traffic-actuated equipment is usually adjusted or modified by relatively simple dial controls requiring no cessation of operation, special tools, or shop work. However, the interrelationship between these dial controls and timing intervals is delicate and complex and must be carefully maintained for efficient traffic control. Therefore, trained and experienced supervision of the operation and adjustment of traffic-actuated equipment should continue beyond the initial installation and adjustment period.

The number and range of the possible adjustments and a description of their meanings are to be found in sections 3E–17 to 19 and 3E–27 to 29.

3E–27 Continuous Operation

Since traffic-actuated signals which are properly adjusted operate effectively in periods of light traffic and tend to cause a minimum of unnecessary delays, they should normally be operated at all times as stop-and-go devices. However, they may be placed on flashing operation because of certain special circumstances such as:

1. During breakdowns, repairs, or maintenance.
2. In conjunction with nearby pretimed signals on flashing operation.
3. Upon preemption by a railroad-crossing protective signal.

3E–28 Time Intervals and Adjustments

Greatest efficiency is obtained from traffic-actuated equipment only with careful adjustment of the various features provided. This often requires some trial and experimentation after the installation has been made, and it is recommended that only a qualified person make these adjustments (sec. 3E–26).

Controllers other than traffic-density type

The following may be used as a general guide to the proper setting of traffic-actuated controllers of other than the traffic-density type.

Major-Street Minimum Period.—In semi-traffic-actuated equipment this setting determines the major-street green interval. It should be selected in relation to the minor-street extension limit in the same manner in which pretimed signal phases are proportioned. It is normally not less than 20 seconds.

Initial Period.—The initial period plus one unit extension is the minimum green period on actuated phases. It will be given to one or more vehicles waiting at the intersection at the start of the green. The minimum green period must be adequate to clear the maximum number of vehicles which can stand between the detector and the Stop line. The initial period is normally not less than 7 seconds.

Unit extension.—This is the green interval provided for each vehicle as it passes the detector and should be determined by the passage time from detector to Stop line for the slowest vehicle common on the street. This adjustment also determines the length of gap which, if exceeded, permits the right-of-way to be transferred to the other street. It is normally set at a value of 3 to 5 seconds.

Extension limit.—The extension limit terminates the green phase only when continuous traffic prevails and cross traffic waits. When traffic becomes very heavy on both streets, the signal operates in effect as a pretimed signal, and the extension limit determines the proportion of time to be allotted to each street and establishes a cycle length as well.

Clearance interval.—The clearance interval is set at a value that will permit traffic to come safely to a halt when a red signal is displayed. **The vehicle clearance interval shall be not less than 3 seconds.** Where conditions warrant a clearance interval exceeding 5 seconds, it should be broken into a yellow clearance interval of 3 to 5 seconds and an all-red interval (sec. 3B–23).

Pedestrian interval and pedestrian clearance interval.—These settings should conform to the recommendations of section 3F–7.

Recall switch.—This feature requires the right-of-way to revert to the street selected whenever the unit extension or extension limit is exceeded on the opposing phase. It may be used to assure a rotation of right-of-way when one or more detectors are inoperative.

Two-phase traffic-density controllers

The following adjustments are unique to two-phase controllers of the traffic-density type. Multiphase controllers of this type have some but not all of the adjustments listed.

Minimum green, added green, and number of actuations.—With traffic-density equipment the minimum-green portion is set at a low value which will constitute the shortest green phase possible under extremely light traffic. The interval is increased from this value by the amount set on the added-green adjustment for each car which arrives on the red phase in excess of a number set on the number of actuations before minimum green starts to increase adjustment. The three adjustments should be so set that sufficient green will be available to clear the maximum number of vehicles which can be stored between the detector and the Stop line.

Passage time.—This setting is analogous to the unit extension discussed above. It should be set at a value sufficient to allow a car to travel from detector to Stop line at the prevailing speed on the street. Actuations received during the passage time immediately preceding the termination of a green phase are treated by the controller as if received on the red phase.

Allowed gap and waiting time.—These settings together determine the low value to which the unit extension on the green phase will reduce and the amount of time after the first cross-street actuation before this value is reached.

Allowed gap and number of waiting cars.—These settings have the same effect as those above except that the unit extension is reduced by the number of waiting cars rather than time.

Allowed gap and actuations per 10 seconds.—These settings enable the controller to react to the increase in headway or "straggling" of vehicles moving on the green phase. These settings together determine the low limit to which the unit extension for a phase will reduce and the frequency of actuation on that phase which will cause this reduction to take place.

Platoon carry-over.—This feature adds to the count of number of cars waiting on the red phase the selected percentage of the actuations received during the preceding phase. This acts to reduce the unit extension on the opposing green phase more rapidly and thus favor the first street during heavy traffic periods.

Recall switch.—The recall on traffic-density equipment differs from that previously described in that the right-of-way will revert to the street selected only if a gap exceeding the passage time occurs on the opposing green phase.

3E–29 Sequence of Intervals and Phases

The sequence of intervals with traffic actuation is determined by the demands of vehicles and pedestrians. With simple two-phase operation the various color sequences are provided in fixed order as the controller responds to the actuation on the two streets. While the sequence of intervals is always the same, the duration of intervals is governed by traffic demands.

Traffic-actuated controllers can be provided with means so that actuation or absence of actuation will cause skipping, splitting, or initiating of intervals for special purposes, such as for pedestrians and left-turn movements. Such installations require thorough engineering in order to obtain effective operation through skillful layout and timing of sequences.

The length of pedestrian and vehicle clearance periods shall be adequate for all possible sequences of phases.

F—PEDESTRIAN SIGNALS

Section 3F–1 Definition

Pedestrian signals are traffic signals erected for the exclusive purpose of directing pedestrian traffic at signalized locations.

3F–2 Warrants

Pedestrian signals shall be installed in conjunction with vehicular traffic signals already meeting one or more of the minimum warrants previously set forth for pretimed or traffic-actuated signals (secs. 3D–3 to 9; 3E–3, 4), under any of the following conditions:

1. When a traffic signal is installed under the pedestrian volume warrant (sec. 3D–6).
2. When pedestrians and vehicles move during the same phase and properly adjusted pedestrian clearance intervals are needed to minimize vehicle-pedestrian conflicts.
3. When an exclusive phase is provided or made available for pedestrian movement in one or more directions, all vehicles being stopped.
4. When heavy vehicular turning movements require a semi-exclusive pedestrian phase for the protection and convenience of the pedestrian.
5. When pedestrian movement on one side of an intersection is permissible while through vehicular traffic is stopped to protect a vehicular turning movement on the other side of the intersection.
6. When an intersection is so large and complicated or a street so wide that vehicular signals would not adequately serve pedestrians.
7. When the minimum green intervals for vehicles at intersections with traffic-actuated controls is less than the minimum crossing time for pedestrians and equipment is provided which extends the vehicular green time upon pedestrian actuation.
8. When multiphase or split-phase timing would tend to confuse pedestrians guided only by vehicle signal indications.
9. When pedestrians cross only part of the street, to or from an island, during a particular phase.

3F–3 Type of Control

The control of pedestrian signal indications may be accomplished with the timing mechanism normally employed with traffic signals, in which case the pedestrian phase or indication is given at a predetermined point during each cycle; or the control may be such as to permit the use of a push button to introduce the pedestrian phase or indication in accordance with the needs of pedestrian traffic.

As a general rule, the installation of pedestrian signals at nonintersectional locations is to be avoided. However, when such signals are required (by conditions such as listed in sec. 3E–4), the pedestrian-actuated type of control, coordinated with adjacent signals, should be employed.

3F-4 General Design Requirements

Pedestrian signal indications should attract the attention of and be clearly readable or understandable to the pedestrian both day and night and at all distances from 10 feet to the full width of the area to be crossed.

All pedestrian signals shall be rectangular in shape and shall contain the lettered messages WALK and DONT WALK. The two basic types described below and shown in figure 3-4 are approved as standard for pedestrian signals:

Gas-Filled Tubing Type.—**The letters shall be at least 4½ inches in height and shall be in two lines. The WALK indication shall be green and the DONT WALK shall be red. The messages shall consist of (a) gas-filled formed tubing, or (b) cut-out letters illuminated by gas-filled tubing.**

Incandescent type.—**The letters shall be at least 3 inches high. The WALK and the DONT WALK indications shall be in separate signal sections. The WALK lens shall be white glass meeting the latest standards of the Institute of Traffic Engineers[18], with either (a) all except the letters obscured by an opaque material, or (b) an opaque band at least 5⅝ inches high across the center of the lens obscuring all except the letters and a band of white at the top and bottom. The DONT WALK lens shall be orange glass, meeting the latest standards of the Institute of Traffic Engineers above cited, with all except the letters obscured by an opaque material.**

Wherever a WALK indication is provided there shall also be provision for a DONT WALK signal indication. Particular care should be given to the design and construction of the gas-filled tubing type of signal so that in case of an electrical or mechanical failure of the word DONT, the word WALK will also remain dark.

All pedestrian signals within one intersection shall be of the same approved type.

Former editions of this manual have authorized the message WAIT as an alternate to DONT WALK. WAIT is believed, however, to be less readily understood by pedestrians and is too easily mistaken for WALK. It is therefore deleted as a permissible standard.

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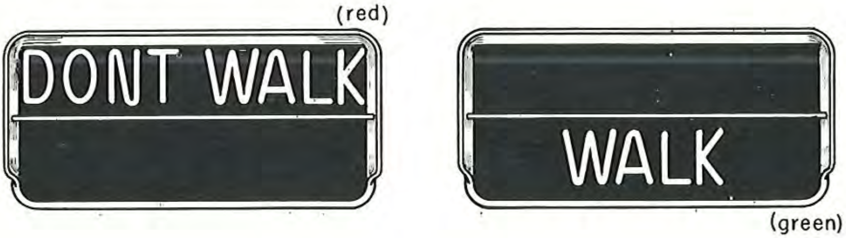
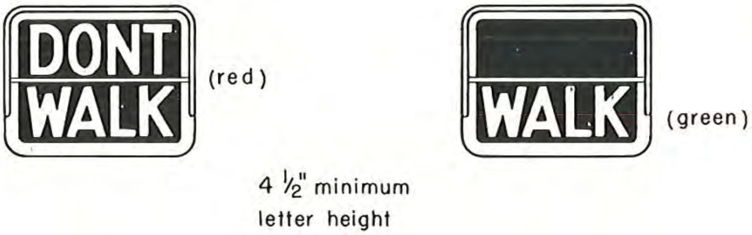
[18] In preparation, to be available in 1961.

I. GAS-FILLED TUBING TYPE

FORMED LETTER DESIGN


(red)
DONT WALK
WALK
(green)

CUT-OUT LETTER DESIGN


DONT
WALK
(red)
WALK
(green)
4 ½" minimum
letter height

2. INCANDESCENT TYPE

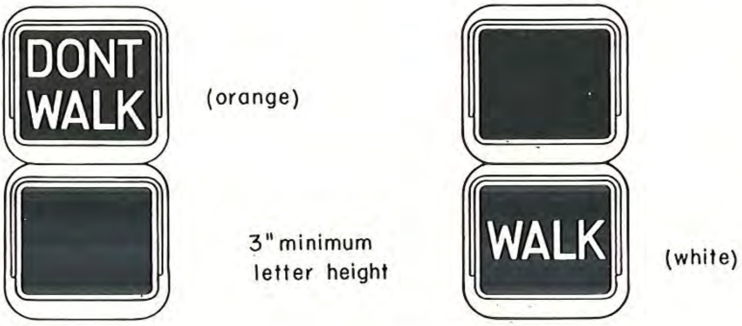

DONT
WALK
(orange)
3" minimum
letter height
WALK
(white)

Figure 3–4. Pedestrian signal design standards.

3F–5 Meaning of Indications

The meanings of pedestrian signal indications are as follows:

WALK.—While the WALK indication is illuminated, pedestrians facing the signal may proceed across the roadway in the direction of the signal and shall be given the right of way by the drivers of all vehicles.

DONT WALK.—While the DONT WALK indication is illuminated, either steady or flashing, no pedestrian shall start to cross the roadway in the direction of the signal, but any pedestrian who has partly completed his crossing during the WALK indication shall proceed to a sidewalk, or to a safety island if one is provided.

3F–6 Location

Pedestrian signals shall be mounted with the bottom of the signal not less than 7 feet nor more than 10 feet above the sidewalk level and so that there is a signal in the line of vision of pedestrians crossing in any direction.

The DONT WALK indication shall be mounted directly above or integral with the WALK indication.

Pedestrian signals may be mounted separately or on the same support with vehicular signals. **When mounted with vehicular signals there shall be a physical separation between the two signal groupings.** Where feasible, the vehicular signal should not be directly visible from the start of the delineated crosswalk. **The pedestrian signal head shall be so positioned and adjusted as to provide maximum visibility at the start of the controlled crosswalk.**

Signals installed at nonintersectional crossings shall follow the usual location standards for both pedestrian and vehicular signals.

Pedestrian-actuated signals shall have a push-button detector 3½ to 4 feet above the surface of the sidewalk at each end of the crosswalks where actuation is required and on any island or median where a pedestrian may otherwise become stranded. A permanent-type sign explaining its use shall accompany each push-button detector (secs. 3E–25, 1B–36).

3F–7 Operation

Pedestrian indications shall be steady burning except during the pedestrian clearance interval, when the DONT WALK may be flashing. When traffic signals at the intersection are on standard flashing operation, pedestrian signals shall be extinguished.

There are several ways in which pedestrian signal intervals can be combined with vehicular signal intervals. Four basic combinations are described as follows:

Combined pedestrian-vehicular phase.—Signal phasing wherein pedestrians may proceed to use certain crosswalks parallel to the through vehicular movement and wherein vehicles are permitted to turn across the said crosswalks.

Semi-exclusive pedestrian-vehicular phase.—Signal phasing wherein pedestrians may proceed to use certain crosswalks with parallel or other vehicular movements, but wherein vehicles are not permitted to turn across these crosswalks during the pedestrian movement.

Leading pedestrian phase.—Signal phasing wherein an exclusive pedestrian phase, in advance of the minor-street vehicular phase, is provided for pedestrians crossing the main street only.

Exclusive pedestrian phase.—Signal phasing wherein pedestrians may proceed to cross the intersection in any direction during an exclusive phase while all vehicles are stopped.

In the operation of pretimed signals, when the minimum WALK interval plus the pedestrian clearance interval is greater than the interval necessary for vehicular traffic, the pedestrian interval shall govern and the vehicular interval shall be adjusted accordingly.

Vehicle-actuated signals may provide for pedestrian signal intervals timed as a normal part of the corresponding green interval for vehicles. **If the minimum vehicle interval is not of sufficient length to accommodate a pedestrian WALK and clearance interval, an additional interval for pedestrians shall be provided. This interval includes a WALK interval and pedestrian clearance interval of adequate duration and shall be activated only by pedestrian actuation.** In the absence of a pedestrian actuation this interval is skipped and the DONT WALK indication remains.

Under normal conditions, the minimum WALK interval shall not be less than 7 seconds, so that pedestrians will have adequate opportunity to leave the curb, and in some cases complete the crossing, before the clearance interval is shown. However, the WALK interval itself need not equal or exceed the total crossing time calculated for the street width, as many pedestrians will complete their crossing during the clearance interval.

A pedestrian clearance interval shall always be provided. The duration shall be sufficient to allow a pedestrian crossing in the crosswalk to leave the curb and travel to the center of the farthest traveled lane before opposing vehicles receive a green indication. (Normal walking speed is assumed to be 4 feet per second.) On a street with a median at least 4 feet in width it is necessary to allow only enough pedestrian clearance time on a given phase to clear the crossing from the curb to the median. In the latter case, if the signal is pedestrian-actuated, an additional detector may be required on the island (sec. 3F–6).

G—SPECIAL TRAFFIC SIGNALS

Section 3G–1 Types of Special Traffic Signals

Special traffic signals include:

1. Flashing beacons.
2. Lane-direction-control signals.
3. Traffic signals at drawbridges.

Flashing Beacons

Section 3G–2 Definition and Application

A flashing beacon is a section of a standard traffic signal head or a similar-type device having a yellow or red lens in each face, which is illuminated by intermittent flashes.

Flashing beacons perform a useful function at locations where traffic or physical conditions do not justify conventional traffic signals. At other special points of hazard, experience has indicated that the flashing beacon is effective in calling the attention of drivers to these locations.

3G–3 Warrants

Flashing yellow beacon.—The installation of a flashing yellow beacon may be warranted as an advance warning device for an intersection or other location under one or more of the following conditions:

1. Physical obstruction existing in the roadway.
2. Important intersection hidden by an obstruction or sharp curve in the highway.
3. Hazardous horizontal and vertical alinement.
4. Special hazard or traffic regulation.

Flashing red and yellow beacon.—The installation of a flashing beacon at an intersection with yellow flashing on the main street and red flashing on the side street or streets may be warranted by one or more of the following conditions:

1. At intersections where sight distance is extremely limited or where other conditions make it especially desirable to emphasize the need for stopping on one street and for proceeding with caution on the other. This type of installation is effective at intersections where approach speeds are in excess of that warranted by conditions, and drivers need more notification than

can be provided by the use of standard or oversize Stop signs, by Stop signs and Advance Warning signs, or by Advisory Speed signs (secs. 1B–5, 1C–10, 1C–36).

2. A serious concentration of accidents susceptible of correction by the cautioning or stopping of traffic.

3G–4 Types of Control

A flasher device, usually installed in a separate housing remote from the beacon, is used solely to provide intermittent illumination of the beacon lens or lenses.

3G–5 Design

Flashing beacon units and their mountings shall follow the general design specifications for standard traffic signals, which include the following essentials:

1. Each signal unit lens shall have a visible diameter of not less than 8 inches.

2. The illuminating element, lens, reflector, and visor shall each be of such design as to render the lens when illuminated clearly visible to traffic facing the signal at all distances up to 1000 feet under all atmospheric conditions except dense fog.

3. The color of the lens shall be red for stop or yellow for caution, in accordance with Technical Report No. 1 of the Institute of Traffic Engineers.[19]

All flashing contacts should be equipped with filters for suppression of radio interference.

3G–6 Location

The particular purpose of a flashing beacon should largely govern its location with respect to the roadway and the hazard or other condition warranting the beacon. If used alone and located at the roadside, flashing beacons as measured from the bottom of the signal head should be at least 8 feet above the pavement. If suspended over the roadway, the clearance above the pavement should not be more than 17 feet or less than 15 feet. In no case should they be mounted on pedestals in the roadway unless the pedestal is within the confines of a traffic or pedestrian island.

3G–7 Operation

The illuminating element in a flashing yellow (caution) or flashing red (stop) beacon shall be flashed at a rate of not less

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[19] *Adjustable Face Traffic Control Signal Head Standards*, Technical Report No. 1. Revised 1958, Institute of Traffic Engineers, 2029 K Street, N.W., Washington 6, D.C.

than 50 nor more than 60 times per minute. The illuminated period of each flash shall be not less than half and not more than two-thirds of the total cycle.

Flashing beacons generally should be operated continuously throughout the 24 hours of the day.

Lane-Direction-Control Signals

Section 3G–8 Definition and Application

Lane-direction-control signals are traffic signals used to indicate and control the direction of traffic movement on individual lanes of a street or highway. These installations are distinguished by signal units over each lane of the roadway; supplementary signs are often used to explain their meaning and intent. The most common use of lane-direction-control signals is for reversible lane control and details of this application follow (secs. 3G–9 to 14).

3G–9 Design

Lane-direction-control signals shall have one face for each direction of the traffic flow. Each face controlling a lane where the reversible system is in operation shall incorporate a distinctive rectangular signal unit (or units) of adequate size so that the signal indication is at all times clearly visible for 1,000 feet under all atmospheric conditions except dense fog.

The signals shall have a downward pointing green arrow and a red X symbol illuminated on an opaque background (fig. 3–5). Illumination of signals can be by incandescent lamps or gaseous tubing.

Mountings shall permit the signals to be suspended over lanes on cable or fixed supports.

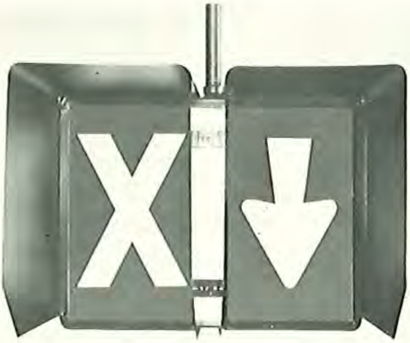

Figure 3–5. Typical lane-direction-control signal units.

3G–10 Meaning of Indications

The meanings of lane-direction-control signals are as follows:

Downward-pointing green arrow.—A driver facing this indication is permitted to drive in the lane over which the arrow signal is located. Otherwise he shall obey all other traffic controls present and follow normal safe driving practices.

Red X symbol.—A driver facing this indication shall not drive in the lane over which the signal is located, and this indication shall modify accordingly the meaning of all other traffic controls present. The driver shall obey all other traffic controls and follow normal safe driving practices.

3G–11 Warrants for Reversible-Lane Operation

The direction of flow of vehicular traffic lanes should be reversed only when competent engineering study shows not only that there is the need for reversible traffic flow, but also that the planned operation can reasonably be expected to operate safely and efficiently. Although warrants for reversible-lane control may be met, local conditions and experience may influence the decision as to their usage. Reversible-lane-control operation may be warranted:

1. When vehicular traffic flow in one direction on a two-way street, highway, bridge, or tunnel having three lanes or more shows the following characteristics:

(a) *Congestion.*—A street or highway can be said to be congested if the average speed of vehicles during peak periods decreases by at least 25 percent over normal period experience, or if there is a noticeable back-up at signalized intersections, so that most vehicles miss completely one or more green signal intervals. Under these conditions calculations will show a traffic demand in excess of rated capacity. Reversible traffic flow has been especially successful on routes where there is a high percentage of commuter traffic.

(b) *Periodicity of congestion.*—Since traffic lanes are usually reversed at a fixed time each day, the periods during which congestion occurs should be relatively stable and predictable.

(c) *Suitable ratio of directional traffic volumes.*—Reversing the direction of a lane requires that the additional capacity for the heavy direction be taken from the traffic moving in the opposite direction. Calculations of volumes per lane, based on a traffic count of all movements, will determine whether the number of lanes in the counter direction can be reduced, how many lanes shall be allocated to each direction, and the times at which the reversal should begin and end. Usually volume ratios of 66 to 75 percent in the predominant direction are taken as a basis for instituting reversible lanes.

(d) *Capacity at access and egress points.*—It is extremely important that there be adequate capacity at the terminal points of the reversible-lane system, with an easy transition of vehicles between the normal and reversed lane conditions. Installation of a reversible system with insufficient terminal capacity may result in an aggravation of the traffic problem and a waste of public funds.

2. When traffic movement at toll-booth areas requires reversal in direction of traffic flow for efficient operation.

3. When traffic movement in one direction at an entrance or exit of a parking lot at an industrial plant, stadium, shopping center, or similar facility greatly exceeds the capacity of the traffic lanes allocated for handling balanced traffic flow.

4. When a heavy traffic movement is slowed down and congested on a long uphill grade of a three-lane roadway because of slow-moving commercial vehicles traveling up the hill, thereby warranting the use, at times, of two lanes for uphill and one lane for downhill movement.

5. When temporary road conditions reduce the number of lanes normally available to handle traffic movement, even though it is extremely unbalanced at various periods of the day.

3G–12 Types of Control for Reversible-Lane Operation

The type of control provided for reversible-lane operation should be such as to permit either automatic or manual operation of the lane-direction-control signals. The control mechanism should permit the illumination of the red indications in both directions in the same lane for those lanes where the traffic flow is subject to being reversed. The possibility of an erroneous indication of green in both directions in the same lane should be avoided by wiring the green indication so that it can be illuminated only when the red indication shows in the opposite direction.

3G–13 Location of Signals for Reversible-Lane Operation

A lane-direction-control signal head with a face for each direction of reversible traffic to be controlled shall be located over the center of each reversible lane of the roadway at the beginning and end of the lane-controlled section. Confirming lane-direction-control signals over other lanes are optional. **If the area to be controlled is more than 1,000 feet in length, or if the vertical or horizontal alinement is curved, intermediate signal indications**

shall be placed over each reversible lane at frequent enough intervals so that motorists will at all times be able to see at least one indication and preferably two (due to the possibility of a burnout of a single indication) along the roadway, and will have a definite indication of the lanes specifically reserved for their use. At the terminal and intermediate signal installation points on the lane-controlled sections, signal indications above the reversible lanes shall be located in a transverse straight line at right angles with the roadway alinement. On roadways having intersections controlled by traffic signals, these lane-control indications shall be placed sufficiently far in advance of or beyond such traffic signals to prevent them from being misconstrued as traffic control signals. The use of twelve-inch traffic signal lenses may also aid in distinguishing the two types of signals (sec. 3B–6).

3G–14 Operation of Reversible-Lane Signals

All reversible-lane-control signals shall be coordinated and wired to a master control which will operate so as to permit signal indication faces for each direction in any of the reversing lanes to change from red to green or from green to red, except that the showing of green in both directions over the same lane shall be guarded against by electrical interlock. It also shall be possible to show a red indication in both directions in any of the lanes subject to reversing traffic flow. This latter feature permits the establishment of a neutral area or safety zone during the changeover period. The transitional interval, when both directions have a red indication, should be of sufficient length to minimize the hazard of opposite-direction conflicts on the reversible lane or lanes. The changeover should normally be made during a period of light traffic, but in an emergency traffic situation it can be made at any time.

The signals shall be operated continuously (sec. 3B–21).

Traffic Signals at Drawbridges

Section 3G–15 Application

Signals installed at drawbridges to control vehicular traffic are a special application of highway traffic signals.

3G–16 Warrants

Traffic signals shall always be used in conjunction with drawbridge gates. They should also be used with other types of protection commonly employed at drawbridges.

3G–17 Design

The traffic signal heads and mountings shall follow the standard design specifications of traffic signals. Drawbridge signals may be supplemented with bells which operate with the red signal indication to provide additional warning to drivers.

If prevailing approach speeds are in excess of 25 miles per hour, signal heads with 12-inch lenses and with 100-watt lamps or larger shall be provided (sec. 3B–6).

Where physical conditions prevent a driver from having a continuous view of at least one signal indication for approximately 10 seconds before reaching the Stop line, an auxiliary signal location shall be used to provide this visibility. If physical conditions make it impossible to provide any location which can be seen for 10 seconds in advance, a flashing yellow beacon (secs. 3G–2 to 7) or a Signal Ahead sign (sec. 1C–16) shall be erected in a suitable position to warn approaching traffic.

A flashing yellow beacon utilized in this manner may be interconnected with the drawbridge signal controller in such manner as to flash yellow during the period when drivers passing this unit at legal speed for the roadway section will encounter a red signal upon arrival at the signalized drawbridge approach.

3G–18 Location

Traffic signals shall be located at both ends of the movable span. To assure positive visibility two signal heads shall be mounted on each approach to the movable span. Their location should conform insofar as practicable with the standards for other signals (sec. 3B–12), except that one signal should be at the left side or over the left half of the roadway. They should ordinarily be not less than 50 feet nor more than 100 feet in advance of the movable span.

3G–19 Operation

Traffic signals at drawbridges shall be interconnected with the drawbridge gates, and, if feasible, with other signals on the same street or highway within 500 feet of the bridge. Not less than 15 seconds before the gates are closed, the signal shall change from green to yellow to red. While the gates are closed and the draw is open, the signals shall show a continuous red. After the draw is closed and the gates are opened, the indication shall change to a steady green and remain so until the next bridge opening.

If the drawbridge is close to a railroad grade crossing and there is a possibility that traffic may be stopped on the railroad crossing as a result of the bridge opening, a supplementary traffic signal may be required at an intersection on the approaches near the grade crossing. In this event extreme care should be used in planning the signal layout and operation so as to avoid the creation of confusion and hazard to motorists, either at the drawbridge or at the grade crossing. Normally such installations should be interconnected to provide coordination in signal indications under a given set of conditions. Other factors affecting railroad-highway grade crossings are presented in sec. 3B–25.

H—TRAIN-APPROACH SIGNALS AND GATES

Section 3H–1 Railroad-Highway Grade-Crossing Protection

At railroad-highway grade crossings where studies indicate the need of protection beyond that provided by signs, signals should be installed which indicate the approach and passage of trains. The signals may be supplemented by gates which extend across the lane or lanes of the approaching traffic while trains are approaching and occupying the crossing. The following sections apply only to signals and gates of the automatic type.

Where traffic signals are located at intersections in close proximity to the train-approach signals, particular attention must be given to the coordination of the two installations. (sec. 3B–25).

3H–2 Classification and Definitions

Railroad-highway grade-crossing signals are classified as flashing-light or wigwag signals, but both types should not be used at the same crossing.

A flashing-light signal is a signal in which indication of the approach of a train is given by two horizontal red lights flashing alternately at predetermined intervals.

A wigwag signal is a signal in which the indication of the approach of a train is given by a horizontally swinging disk and a red light enclosed in the disk.

A railroad-highway grade-crossing automatic gate is a device which, when indicating the approach and passage of a train, presents toward the highway in both directions the appearance of an arm being lowered to or in a horizontal position, and extending over the traveled roadway a sufficient distance to cover the lanes used by traffic approaching the crossing.

A No Right Turn or No Left Turn signal is a device which, when indicating the approach and passage of a train, presents the aspect of an illuminated sign bearing the legend NO RIGHT TURN or NO LEFT TURN, surmounted by a flashing yellow marker light.

3H–3 Warrants

Automatic signals or automatic signals and gates of the type described herein shall be installed at railroad-highway grade crossings where a study of the crossing by competent engineers indicates a need for advance warning of the approach of trains. This assembly of devices shall be used for no other purpose.

When a highway adjacent to and approximately paralleling a railroad intersects or joins another highway that crosses the railroad at grade, a No Right Turn or No Left Turn signal (secs. 3H–2, 6) may be used on the parallel highway to supplement the highway grade-crossing signals located at the crossing.

3H–4 Meaning of Indications

Railroad-highway grade-crossing signal indications shall have the meanings ascribed to them in the Uniform Vehicle Code, Section 11–701.

3H–5 Types of Control

Flashing-light and wigwag signals may be controlled either manually or automatically. **The flashing-light signal shall operate upon the approach of trains from either direction on the tracks for which protection is provided, and they shall continue to operate until the rear of the train reaches or clears the crossing. The control of No Right Turn and No Left Turn signals shall be correlated with the grade-crossing signal control.**

Automatic gates may be controlled either manually or automatically. **The gates shall operate upon the approach of trains from either direction on the tracks for which protection is provided. They shall reach the full horizontal position before the arrival of the fastest train operated over the crossing and shall remain down until the rear of the train has cleared the crossing.**

3H–6 Design

Flashing-light signals.—The following provisions relate to the design of flashing-light signals:

1. Signal lights shall be arranged to provide adequate indication to approaching vehicular traffic. They shall be mounted as shown in *Railroad-Highway Grade-Crossing Protection*, Bulletin No. 5 (or subsequent issue), Association of American Railroads, Train Operation, Control and Signals.[20]

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[20] Available from the Association of American Railroads, Transportation Building, Washington 6, D.C.

2. Electric-light units shall be in accordance with Association of American Railroads' Signal Section Specification 190 or 232.[21] Roundels and outer lenses shall be a minimum of 8⅜ inches in diameter and shall be in accordance with Signal Section Specification 69 of the Association of American Railroads.

3. The Railroad Crossbuck sign and the signal shall be mounted on the same post.

Wigwag signals.—The following provisions relate to the design of wigwag signals:

1. A wigwag signal shall consist of a disk 20 inches in diameter, in which a lamp with red lens or roundel is provided for night indication.

2. The disk shall be supported by a pivoted rod, and the length of stroke of the swinging light in the disk measured horizontally between extreme positions shall be 30 inches.

3. Lenses or roundels shall be in accordance with Signal Section Specification 69 of the Association of American Railroads.[22]

4. The railroad crossbuck sign and the signal shall be mounted on the same post.

Automatic gates.—The following provisions relate to the design of automatic gates:

1. An automatic gate used for the protection of highway traffic at a railroad-highway grade crossing, when indicating the approach of a train, shall present toward approaching highway traffic the aspect of an arm equipped with red lights being lowered across the lane or lanes used by traffic approaching the crossing, or at rest in the horizontal position across the lane or lanes.

2. An automatic gate, when installed, shall serve as an adjunct to a highway crossing signal of the flashing-light type. The gate should be mounted on the same assembly as the flashing-light signal; however, where conditions require, it may be mounted on an independent pipe, post, or pedestal located between the signal and the track.

3. The bottom of the gate arms, when in the horizontal or lowered position, shall be not less than 3½ feet nor more than 4½ feet above the crown of the roadway and, when not indicating the approach of a train, shall neither obstruct nor interfere with highway traffic.

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[21] Specifications available from the Communication and Signal Section, Association of American Railroads, 59 East Van Buren Street, Chicago 5, Illinois.

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[22] See footnote 21.

4. Each gate arm extending over the highway shall have three red lights shining in both directions along the highway. The light nearest the tip shall burn steadily and the other two lights shall flash alternately.

5. The gate arms shall be striped on both sides with 16-inch alternate diagonal stripes of white and black.

6. Lenses shall be in accordance with Signal Section Specification 69 of the Association of American Railroads.[23]

Insofar as practicable, the mechanisms should be so designed that if the arms, while being raised or lowered, strike or foul an object they will readily stop and, upon removal of the obstruction, assume the position required by the control mechanism.

No Right Turn and No Left Turn signals.—The following provisions relate to the design of No Right Turn and No Left Turn signals:

1. The aspect shall be that of an illuminated sign bearing the legend NO RIGHT TURN or NO LEFT TURN surmounted by a flashing yellow marker light.

2. The signal shall be in accordance with Association of American Railroads' Signal Section Specification 231.[24]

3. The marker light shall be in accordance with Signal Section Specification 190 or 232 of the Association of American Railroads,[25] except that it shall display yellow and be arranged for fastening to a bracket.

3H–7 Location

One signal or one signal and gate shall be placed on each side of the track or tracks, except in the cases of established one-way streets, where the installation shall be made on the approach side. Signals and gates shall preferably be placed on the right of approaching traffic.

The location of signals and automatic gates for railroad-highway grade-crossing protection should be determined after inspection and study at the site. In addition to providing for adequate clearances, consideration should be given to the type of highway, angle of crossing, and visibility to drivers approaching the crossing. The location of the signal should be not less than 2 feet beyond the curb, the edge of the traveled way, or the outer edge of the paved shoulder when the shoulder is continued across the tracks.

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[23] [24] [25] See footnote 21.

The No Right Turn or No Left Turn signal, when used, shall be placed as close to the intersection as practicable.

3H–8 Installation

Signals and gates shall be installed in accordance with the standards and practices recommended in *Railroad-Highway Grade-crossing Protection*, Bulletin No. 5 (or subsequent issue), Association of American Railroads, Train Operation, Control and Signals.[26] Figure 3–6 illustrates typical train-approach signal installations.

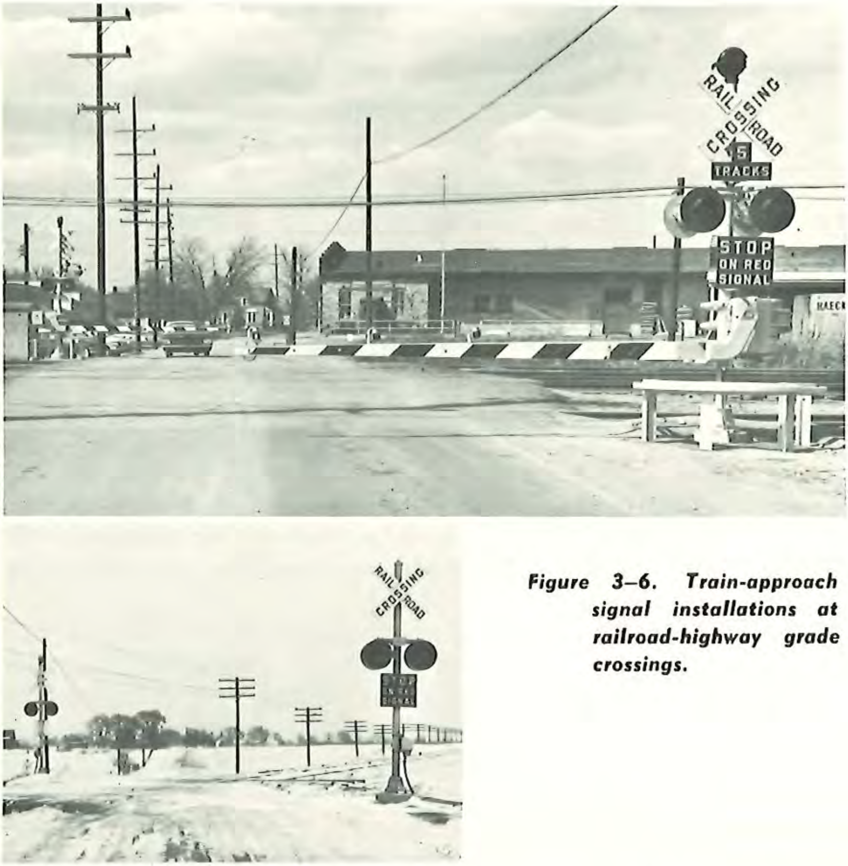

Figure 3–6. Train-approach signal installations at railroad-highway grade crossings.

3H–9 Operation

Signals and devices which indicate the approach of a train shall be so controlled that they will operate for such period of time

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[26] Available from the Association of American Railroads, Transportation Building, Washington 6, D.C.

before the arrival of any train operated over the crossing as is reasonably required to afford protection. Where the greatest distance along the highway is 35 feet or less between the signal on either side of the crossing and the clearance beyond the farthest track from such signal on which trains operate at medium or higher speed, the signals shall operate for not less than 20 seconds before the arrival of any train on any such track. Where this distance is more than 35 feet, the 20 seconds should be increased to provide the additional time required for highway vehicles to clear the crossing.

Circuits for the operation of automatic gates shall be so arranged that the gate arm shall start its downward motion not less than 3 seconds after the signal lights start to operate. The gate arm shall reach full horizontal position before arrival of the fastest train operated over the crossing and shall remain in that position until the rear of the train has cleared the crossing.

Local conditions may require an operating time longer than 20 seconds before arrival of the train, but too long an operation by slow trains is undesirable. Uniform time control for all train speeds is the most desirable arrangement, and at crossings where there is considerable difference between high and low train speeds and where travel on the highway is heavy, provision for a type of circuit control that will insure equal or approximately equal timing should be considered.

Electric lamps in the flashing-light type of signals shall flash alternately. The number of flashes of each lamp per minute shall be 30 (minimum) to 45 (maximum). Each lamp shall be illuminated for approximately one half of the operating cycle.

Each flashing-light unit shall have a range in accordance with Signal Section Specification 190 or 232 of the Association of American Railroads. [27]

With the wigwag type of signal, movement of the swinging disk from one extreme to the other and back constitutes a cycle. **The number of cycles per minute shall be 30 (minimum) to 45 (maximum).**

The electric-light unit of the wigwag signal, when the disk is suspended vertically, shall have a range at night of 1,500 feet through a total angle of not less than 20 degrees when a 10-watt lamp rated at 1,000 hours is burned at rated voltage. The lamp shall burn while the disk is swinging.

The No Right Turn or No Left Turn signal shall be legible only when the crossing signal indicates the approach of a train.

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[27] See footnote 21.

It shall be illuminated without flashing during the period that the crossing signals are operating, and the yellow marker light shall flash in synchronism with the crossing signals.

3H–10 Maintenance

Automatic signals and gates shall be kept well painted and in a good state of efficiency. The surfaces of lenses on signal and gate-arm lights shall be kept free from such deposits as soot or other materials that will seriously affect their efficiency.

Part IV

ISLANDS

A.—GENERAL CONSIDERATIONS

Section 4A–1 Functions of Islands

A traffic-control island is a defined area between traffic lanes for control of vehicle movements or for pedestrian refuge. Within an intersection area, a median or an outer separation is considered to be an island. An island may be designated by paint, raised bars, mushroom buttons, curbs, guideposts, pavement edge, or other devices. For the purposes of this Manual, an island includes not only the designated area but also all end protection and approach-end treatments.

It should be realized that islands constitute an integral part of the geometric design of streets and highways and should be included in overall projects for construction. At times, however, an island may have to be installed at an existing intersection to improve or correct an outdated design. This Manual primarily treats the traffic-control characteristics of islands rather than their design features; however, certain minimum standards are suggested. The treatment of islands herein applies largely to urban and suburban installations which are usually located in relatively restricted roadway or intersection areas. For guides to street and highway design, including the design of islands, reference should be made to *A Policy on Geometric Design of Rural Highways*, 1954, and *A Policy on Arterial Highways in Urban Areas*, 1957, both of which have been adopted and published by the American Association of State Highway Officials.[28]

4A–2 Classification

Islands may be classed functionally and physically as follows:

1. Pedestrian refuge islands (secs. 4B–1 to 7). Loading islands are considered to be a special form of refuge islands (sec. 4B–7).
2. Traffic divisional islands (secs. 4C–1 to 6).
3. Traffic channelizing islands (secs. 4D–1 to 6).

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[28] Available from the American Association of State Highway Officials, 917 National Press Building, Washington 4, D.C.

Illustrations of refuge, divisional, and channelizing islands are shown in figures 4–1 to 4–3.

Pedestrian islands are provided to serve as safety zones for the aid and protection of persons on foot. The right of a pedestrian to occupy a pedestrian island in safety is commonly sustained by law. A safety zone is defined as an area within a roadway, officially set aside for the exclusive use of pedestrians. The Uniform Vehicle Code, (sec. 11–1304), prohibits a motor vehicle from entering a safety zone at any time.

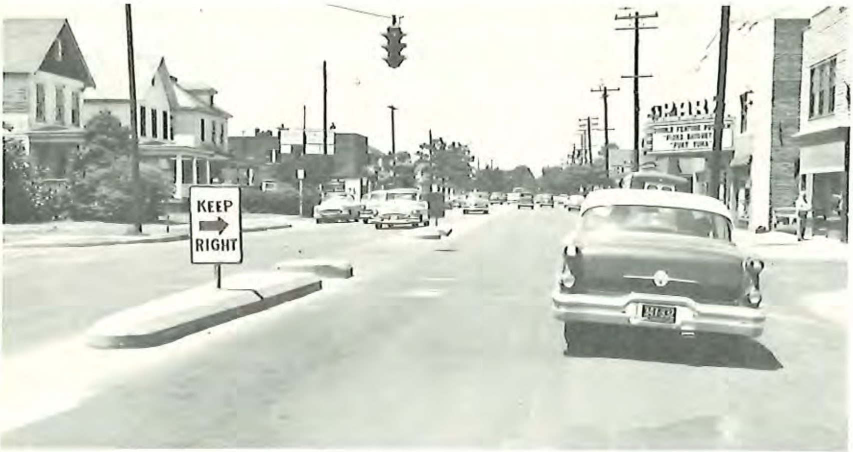

Figure 4–1. ***Pedestrian refuge island with walk-through crosswalk. Approach-end treatment consists of pavement markings and a reflectorized sign.***

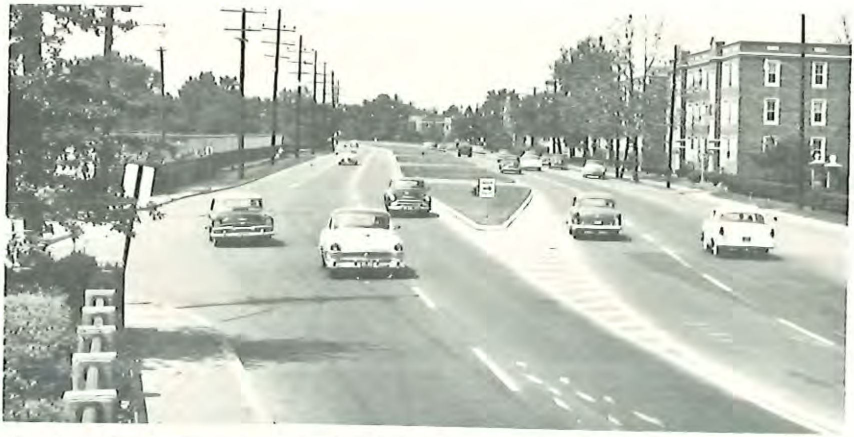

Figure 4–2. ***Turf median outlined by a mountable curb in a suburban area. Approach-end treatment consists of painted lines on the pavement, painted curb, and a reflectorized sign.***

Traffic islands include all areas created for separating and directing vehicular traffic. They may be either channelizing or divisional. Divisional islands serve to divide opposing or same-direction traffic streams that are usually through movements. Channelizing islands are designed to control and direct traffic movement, usually turning movements.

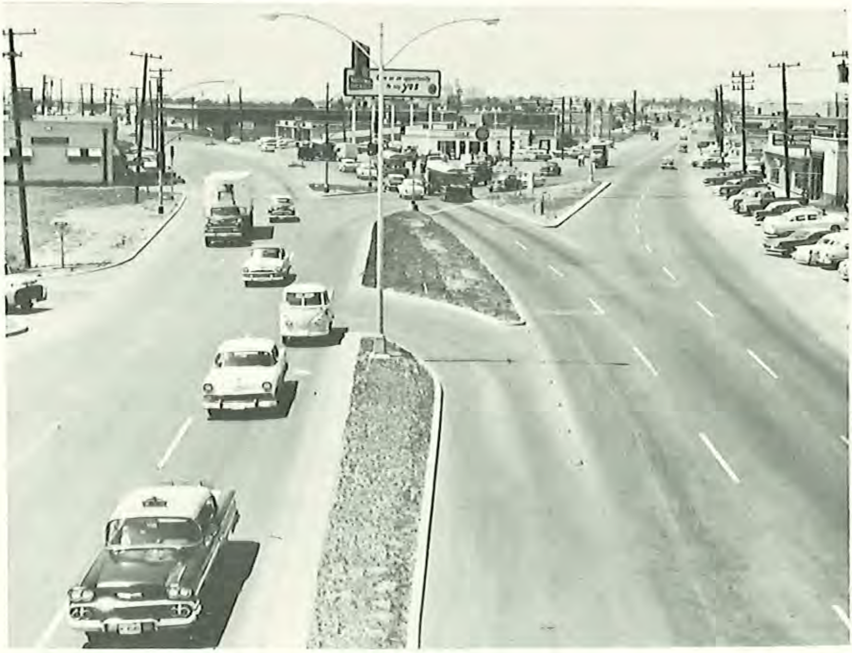

Figure 4–3. Channelizing islands at a signalized Y-intersection. Concrete curbs delineate the island edges. Mushroom buttons separate a left-turn lane from the through lanes.

Most islands serve two or all of these functions. Divisional islands at intersections, for instance, nearly always serve as pedestrian refuge islands. Refuge islands located on an otherwise undivided street also function as divisional islands. Except for features and criteria that apply to all islands, each function is discussed separately in this Manual.

4A–3 General Design Elements

The necessity for an island should be determined only by careful study, since it is placed in an area that would otherwise be available for vehicular traffic. The island design should be carefully planned so that the shape of the island will conform to natural vehicular paths and so that a raised island will not constitute a hazard in the roadway. A judiciously placed island at an intersection on a wide street may eliminate the need for traffic signal control by channelizing traffic into orderly movements.

The island should be clearly visible at all times and sufficiently in advance so that the motorist will not be surprised by its presence. The island should occupy the minimum of roadway space needed for its purpose and yet be of sufficient size to be noticeable so that motorists will not be likely to run over it. As governed by the design and traffic conditions, the delineation, illumination, reflectorization, signing, and marking for each island should be as recommended in this Manual.

Size and shape.—Islands are generally either narrow and elongated or triangular in shape, are normally situated in areas of the roadway outside the planned vehicle paths, and are shaped and dimensioned as component parts of the street or intersection layout. The actual size differs as governed by site conditions, but the following minimum size requirements should be met to insure that the island will be large enough to command attention. For rural conditions any island should preferably be at least 75 square feet in area, or at least 50 square feet for very restricted conditions. For urban conditions where speeds are low, corresponding values are 50 and 35 square feet. The latter corresponds to a triangular island of about 6-foot dimension between rounded ends on each leg. An elongated island with a minimum width of 4 feet should preferably be at least 20 feet long, and in no case less than 12 feet.

Designation of area.—The form or means of designating an island area varies, depending on its size, location, and function, and also the character of the adjacent area, rural or urban. Generally, islands are delineated by one of the following methods: (1) raised and outlined by curbs and filled with pavement, turf, or other material; (2) formed by pavement markings, buttons, or raised bars on all-paved areas, used in urban districts where speeds are low and space is limited; or (3) unsurfaced, flush with the traveled way, sometimes supplemented by guideposts, stanchions, or other delineators, used for large islands. Island areas of minimum size should be designated by pavement markings, buttons, or raised bars. Small island areas should be designated by vertical curbs when used for pedestrian refuge or for the installation of traffic control devices. Large island areas should be designated by curbs, either mountable or vertical, or by color and texture contrast of vegetative cover, shrubs, mounded earth, guideposts, or signs, or any combination of these (figs. 4–2, 4–3, and 4–4).

Vertical curbs are designed with a face vertical or sloped at an angle less than 20° to the vertical, ordinarily unmountable by vehicles.

Mountable curbs are designed so that vehicles may cross without a severe jolt; usually with a sloping face at an angle between 20° and 60° from the vertical.

The type of curb used to bound an island is dictated by the needs of the situation, which vary according to vehicle speeds, pedestrian traffic, and island types and width. All curbs in the line of traffic flow should be painted yellow (sec. 2C–4). Islands on major streets in urban areas are usually bounded by 5- to 8-inch vertical curbs for the protection of pedestrians, signal and lighting standards, or other traffic control devices (figs. 4–1, 4–7, and 4–23). Whenever a barrier curb is not essential for traffic control or safety a mountable curb should be used. Curbed refuge and channelizing islands, and divisional islands where feasible, should be designed without curb-and-gutter sections adjacent to the islands so that they remain fully visible and roadway widths are unrestricted during periods of pavement surface drainage.

As noted in section 2A–5, raised bars or buttons are sometimes used to designate an island or part of an island (figs. 4–3, 4–4, and 4–10). They should not be used where they constitute an unexpected hazard. These devices should not project more than 1 to 3 inches above the pavement surface, so that any wheel

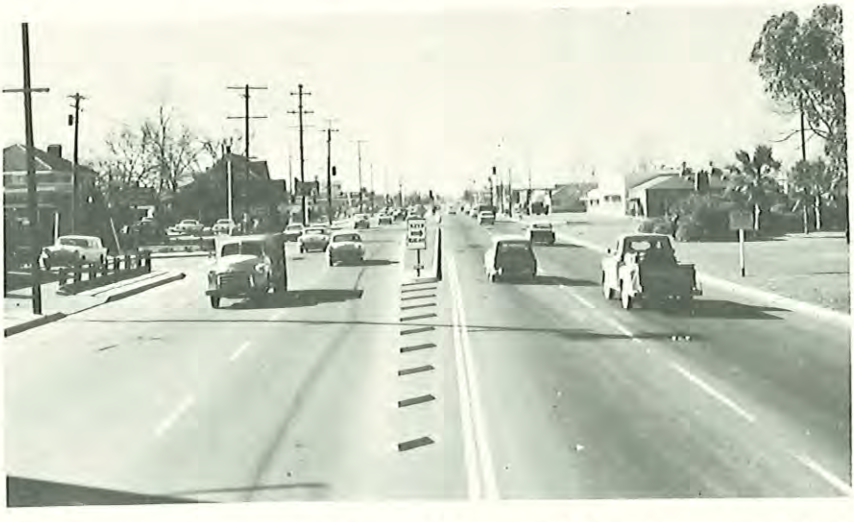

Figure 4–4. The transition from a 4-lane undivided roadway to a 4-lane highway with a curbed median is effected through the use of raised concrete bars and pavement markings. Further warning is given by the use of a sign, a hazard marker, and a high-visibility curb.

encroachment within the area will become obvious to the vehicle driver without a resultant loss of control of the vehicle. A major disadvantage of these devices is that the spaces between them are difficult to keep clean. Pavement markings may be used effectively with raised bars or buttons to designate better the island area.

When an island is installed in an existing intersection or roadway, it is often necessary to provide additional roadway space for traffic movement, since some of the original width is usurped by the width of the island. This usually can be accomplished by the simple expedient of prohibiting parking adjacent to and in the immediate vicinity of the island. As a general rule, parking adjacent to an island is undesirable and unsafe, as its effect is to destroy the geometric pattern for which the island is designed.

4A–4 Approach-End Treatment

The approach end of an island shall be carefully designed to provide, for approaching traffic, a maximum degree of warning of the presence of the island and a definite indication of the proper vehicle path or paths to be followed. This applies directly to the approach to all refuge and directional islands and to individual divisional islands, but is not applicable to island ends at median openings on a divided street or highway.

Various methods of approach-end treatment have been used with satisfactory results, but experience does not yet justify complete standardization. Experimentation should be continued. In effective installations to date the motorist is warned of the island and guided around it by one or by some combination of the following devices:

1. Pavement markings (secs. 2B–15, 17, 18).
2. Object markings (secs. 2C–2 to 4).
3. Signs (secs. 1B–25, 1C–34).
4. Reflecting devices (sec. 2D–2).
5. Flashing yellow beacons (sec. 3G–2, 3).
6. Contrasting pavement colors or textures.
7. Raised bars, buttons, and median blocks (sec. 2A–5).
8. Illumination devices.

Although there is no standardization as to the type of approach-end treatment used, there are standards that should be applied for particular types. The standards of application are discussed in the sections mentioned above and in sections 4A–3 and 4A–4.

The ends of islands first approached by traffic should be preceded by a gradually widening marking or a conspicuously roughened strip on the roadway surface and designed so as to lead the vehicles into natural paths of travel in the desired directions along the island edge. The use of raised bars is often a preferable treatment in advance of curbed island noses. These devices should be combined to the extent practicable with other high-visibility indicators, such as reflectorized curbs, suitably reflectorized or illuminated signs located near the approach end, or reflectors mounted above the island (fig. 4–4).

At the beginning of a divisional or pedestrian refuge island which separates opposing traffic movements the island nose should be offset to the left, as faced by approaching traffic, the right curb of the island forming a diverging taper to deflect traffic toward the right. Where a channelizing or divisional island is introduced between two lanes of traffic moving in the same direction similar offsets should be used, to the extent that space permits, on each side of the nose to direct traffic into the separate roadways.

B.—REFUGE ISLANDS

Section 4B–1 Legal Authority

Refuge islands, being in the roadway, may be established only on the authority of the local or State highway officials having jurisdiction.

A model of legal authority for the establishment of refuge islands, or safety zones, is presented in the Model Traffic Ordinance (sec. 4–12) and authority for the exclusion of vehicular traffic from such islands is provided in the Uniform Vehicle Code (sec. 11–1304).

4B–2 Functions

The main function of a refuge island is to provide a place of safety for pedestrians who cannot cross the entire roadway width at one time in safety because of changing traffic signals or oncoming traffic. In congested areas they also expedite vehicular traffic by permitting some vehicles to proceed without waiting for pedestrians to cross the entire roadway.

4B–3 Design Elements

Refuge islands should be used in urban areas on exceptionally wide roadways or in large or irregularly shaped intersections where there is a considerable amount of pedestrian traffic and where heavy volumes of vehicular traffic make it difficult and dangerous for pedestrians to cross. No refuge island should be placed where it will leave less than two through lanes available for traffic between it and the adjacent curb or another island. However, a turning lane separated from the through lanes by an island may be designed for a single traffic lane (sec. 4D–3 and fig. 4–5). Normally a refuge island should be centered on the median line of the roadway (fig. 4–1).

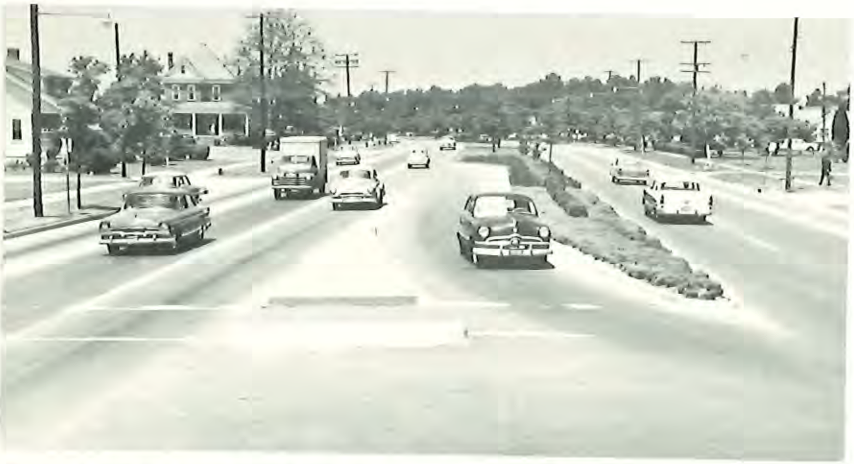

Figure 4–5. Walk-through pedestrian refuge island that also serves to separate a median lane from the through lanes. Approach-end treatment consists of pavement markings and high-visibility painted curb.

Refuge islands should not be located so as to create a hazard for motor vehicles (sec. 4A–3). In areas with fast-moving vehicular traffic, islands not on the roadway centerline should be avoided. Streets with reverse-flow lanes require special consideration in determining island placement. Whenever heavy pedestrian traffic occurs on a street with vehicular traffic moving at relatively high speed, consideration should be given to some additional form of pedestrian protection, such as a pedestrian-actuated traffic signal or a pedestrian grade separation.

In urban areas with slow-moving traffic and many pedestrians, a refuge island should desirably be provided at an intersection with a one-way or two-way roadway six or more lanes in width. At signalized intersections refuge islands are used to expedite vehicular movements by provision of safety zones between different traffic streams. Refuge islands may be required at each intersection along a street. In such case consideration should be given to providing a continuous median divider strip between intersections, as discussed in section 4C–3.

Sections 4A–3 and 4A–4 should be used as guides in the design of refuge islands. It is preferable that part of the island be a raised platform, outlined by barrier curbs, to afford pedestrians a greater sense of security. Part of the area at the crosswalk desirably should be kept at pavement level to facilitate use by baby carriages, wheel chairs, and crippled or infirm persons. Although it is better to have part of the raised platform project beyond the crosswalk on the side towards the intersection (figs. 4–1, 4–5), it is permissible to stop the platform at or within the crosswalk area. Where this is done, a mushroom button or more substantial curb protection should be provided at any corner which otherwise might be encroached upon by turning vehicles. There should be a raised part immediately available for pedestrians to step upon (fig. 4–6).

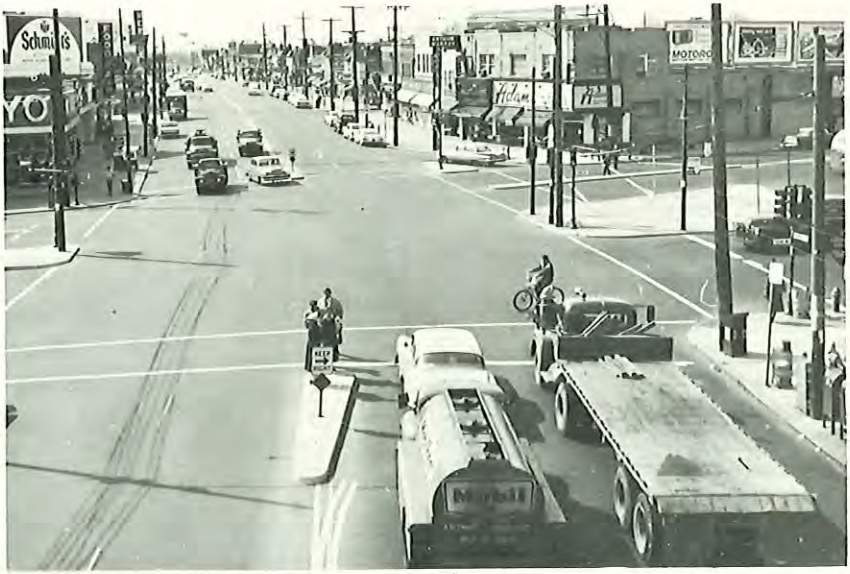

Figure 4–6. Pedestrian refuge island with raised platform ending at crosswalk line. Approach-end treatment consists of pavement markings, reflectorized sign, and hazard marker.

Buffers of concrete block or other massive structure placed on the approach end of a pedestrian refuge island intensify the possibility of physical harm to the occupants of a colliding vehicle while providing a questionable increase in pedestrian safety over more yielding types of barriers. For this reason, massive buffers are no longer being built and posts or guardrail are being used instead (fig. 4–7). In general, there is little current construction of buffers on pedestrian islands. Such barriers should be used only in areas with relatively high vehicle speed, and they should be highly visible at all times. Special illumination or reflectorization may be needed if the barrier is not obvious without it.

Refuge islands should preferably be at least 6 feet and in any case at least 4 feet wide. **The usable length along the roadway,**

including any section at pavement level at the crosswalk, shall not be less than 12 feet or the width of crosswalk, whichever is greater.

4B–4 Illumination and Reflectorization

Refuge islands shall not be installed unless they can be adequately reflectorized and illuminated. Illumination of refuge islands including their approach-end treatment, should be sufficient to show the general layout of the island and immediate vehicular travel paths, with the greatest concentration of illumination at points of possible danger to pedestrians or vehicles, as at barrier curbs, buffers, or other structures. Reflectorization is needed to warn of the presence of the island on nights when illumination may not be in operation.

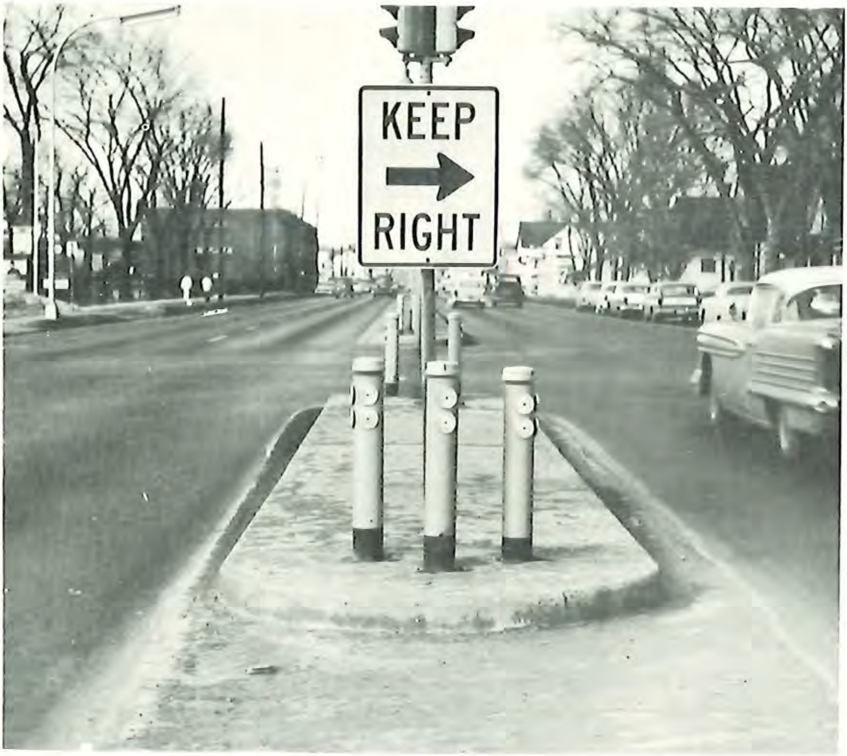

Figure 4–7. Pedestrian refuge island protected by a barrier of steel posts. The reflectorized sign and the reflectors on the posts give advance warning of the island.

4B–5 Signs

Standard signs indicating the permitted direction of flow shall be placed at the approach end of every refuge island that is in the line of approaching traffic. When vehicles are required to pass only to the right of the island a regulatory Keep Right sign (sec. 1B–25) shall be used. When passing is permitted on either side, the Double Arrow warning sign (sec. 1C–34) shall be used. Such signs shall be adequately reflectorized or illuminated.

Parking should be excluded along the curb of the sidewalk adjacent to a refuge island for the length of the island and for such distances beyond the ends as are necessary to expedite the flow of traffic (Uniform Vehicle Code, sec. 11–1003). Where necessary, additional parking restriction signs should be installed (sec. 1B–31).

4B–6 Markings

The approach-end treatment of a refuge island in the line of traffic flow shall include pavement markings as provided in sections 2B–15, 17, and 18.

Where an obstruction is used as part of the approach-end treatment, the ends of all islands toward approaching traffic shall be marked in accordance with section 2C–2. Section 2C–4 will apply if the island curb is the only obstruction. Additional curb markings are not required if the use of a contrasting color, reflectorized paint, or other special treatment has been used to indicate clearly the presence of the island. If in the surrounding area markings are used to indicate that parking is prohibited (sec. 2B–27), the markings should be used opposite refuge islands.

4B–7 Loading Islands

Loading islands are considered herein to be a special class of refuge islands, inasmuch as they serve as a pedestrian refuge while loading and unloading passengers from streetcars or buses, and require the same general design treatment as discussed above. The present trend is to mass-transit vehicles that load at the curb, and it is expected that few new loading islands will be constructed. Where a particular situation necessitates the use of a loading island, details of treatment should be as for pedestrian refuge islands (figs. 4–8 and 4–9).

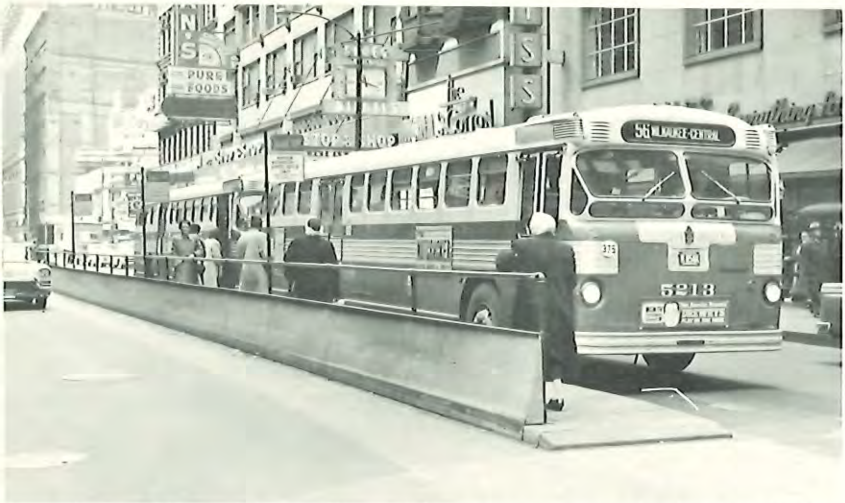

Figure 4–8. Mid-street bus loading platform on a one-way street. The loading area is composed of wood plank deck, and is protected by sheet metal splash plate. Advance warning is given by signs at end facing traffic.

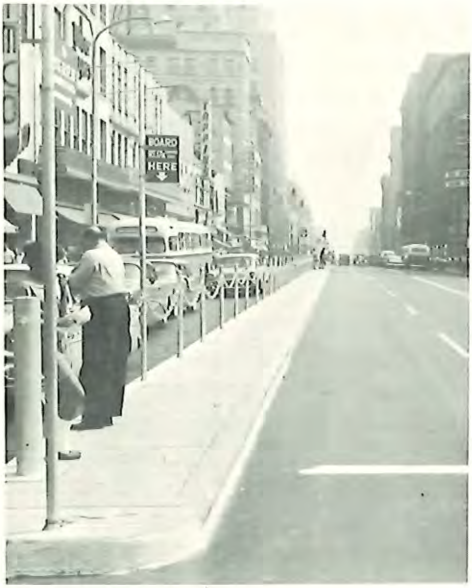

Figure 4–9. Mid-street bus loading platform of concrete. Steel posts and chains provide side protection and discourage mid-block crossings by pedestrians. End protection is provided by heavy steel post and painted curb.

C.—DIVISIONAL ISLANDS

Section 4C–1 Legal Authority

Divisional islands are elements of street and highway design, and accordingly no special authority is required for their installation, since such authority is vested in the agency responsible for highway design.

4C–2 Functions

Divisional islands are placed longitudinally in roadways to divide the traffic stream into two or more parts. Most commonly they separate opposing traffic movements by serving as a central divider. Where continuous, they are a part of the design cross section and are called medians (figs. 4–10, 4–16). Often divisional islands are introduced in advance of an intersection to separate opposing traffic, to serve as a warning of the intersection, or to provide a turn lane (fig. 4–11). They also may be used to separate traffic in the same direction, as when dividing left-turn traffic in a median lane from the through traffic, as shown in figures 4–10 and 4–13, or separating through traffic lanes from an adjacent pavement provided for local service, as in figure 4–12. Divisional islands are used to guide traffic around an obstruction within the roadway, such as a bridge pier, and also at any point where traffic is regularly stopped for toll or inspection purposes. Divisional islands may be located so as to prevent overtaking and passing at hazardous points, as at sharp curves or narrow underpasses.

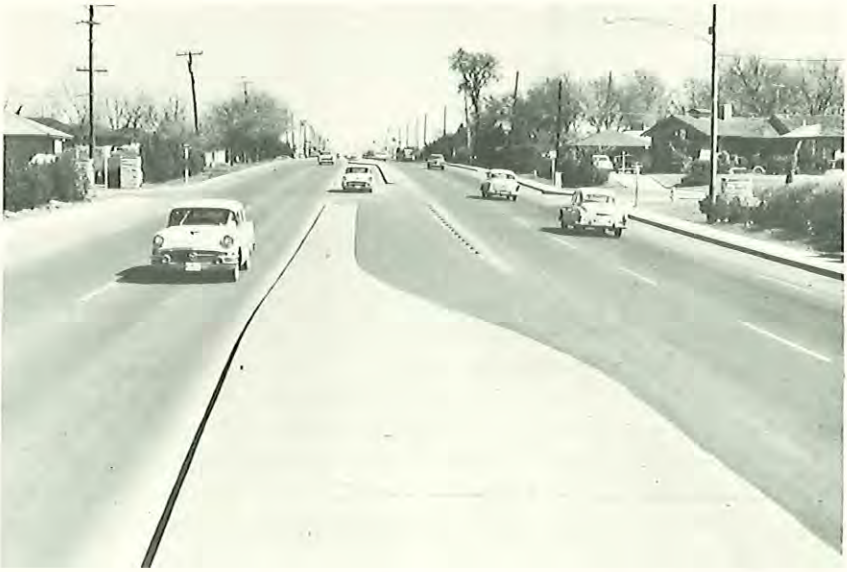

Figure 4–10. Concrete median on a major street in a residential area. Median lanes are provided for storage and safety at intersections. Mushroom buttons separate the left-turn lanes from the through lanes.

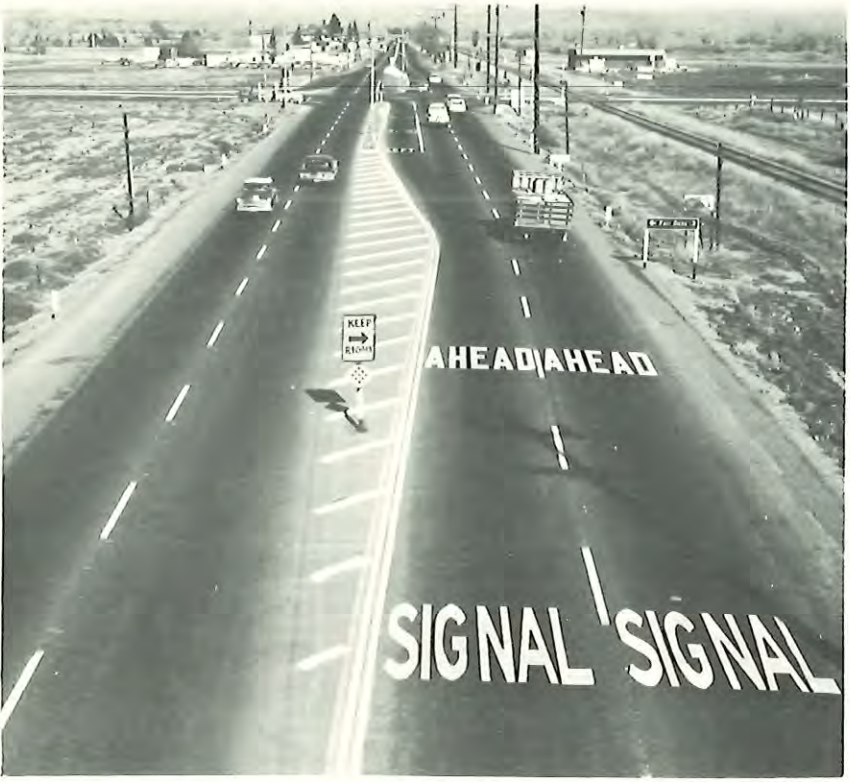

Figure 4–11. Divisional island of raised bars introduced to provide a left-turn lane. The island at the intersection is delineated by mountable curb and is illuminated. Included in the approach-end treatment are a reflectorized sign and a hazard marker.

4C–3 Specific Design Elements

A divisional island (median) is an important and essential element in the design of major thoroughfares in urban areas, if these major traffic arteries are to meet the minimum standards of safety and capacity. Where right-of-way width permits, medians can be used to advantage on other streets. Although a raised median may bar vehicles from left-turn access to alleys and business facilities and results in some indirection in traffic movement, these restrictions are essential if the desired traffic safety and capacity are to be achieved.

The more important functions of a median are as follows:

1. The median provides an insulating area between opposing streams of moving traffic, reducing the strain on drivers and usually resulting in a reduction in the accident rate.

2. Where width is sufficient a median provides protection and

control of cross and turning traffic. One of the most important benefits of a median is obtained when a median or left-turn storage lane is provided. Left-turning vehicles are separated in a protected lane so as not to impede the flow of the through traffic, thus greatly increasing the efficiency, capacity, and safety of the intersection.

3. A median provides a refuge for pedestrians and decreases the need for installation of traffic signals. It makes possible more efficient signing and signalization in that traffic movements are regulated into orderly channels.

4. A median makes it possible for traffic to move smoothly and safely at higher operating speeds.

Where possible, the width of the divisional island should be sufficient to provide protection for vehicles crossing or turning at intersections. Chapter VIII of *A Policy on Geometric Design of Rural Highways,* 1954, and Chapter D of *A Policy on Arterial Highways in Urban Areas,* 1957,[29] should be consulted for an analysis of minimum designs for these conditions. Widths of 20 feet or more are desirable. Although narrow medians do pro-

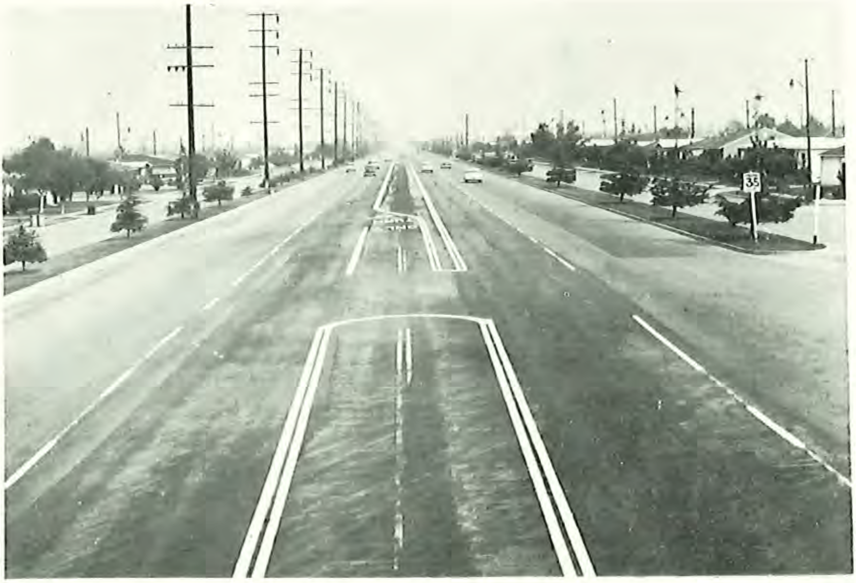

Figure 4–12. ***Expressway with a painted-line median and frontage roads. The divisional island or outer separator is sodded and planted, and outlined by vertical curb.***

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[29] Available from the American Association of State Highway Officials, 917 National Press Building, Washington 4, D.C.

vide some separation of opposing traffic and may serve for pedestrian refuge, medians less than 12 feet in width will not accommodate a median left-turn lane and at cross-street openings provide only partial protection for turning and crossing traffic.

The minimum desirable width of a median which will accommodate a median lane is 16 feet. Where right-of-way is severely limited, median widths of 12 feet have been used with a 10-foot turning lane. Whenever the separator of median lane and opposing through traffic is narrower than 4 feet, it should be composed of a mountable separator, mushroom buttons, or lane markings. Where the separator is 4 feet or wider either mountable or barrier curbs should be used, with the type determined by local conditions (figs. 4–13 to 4–15, and 4–17). For further information on median lane design, the design policies of the American Association of State Highway Officials should be consulted.

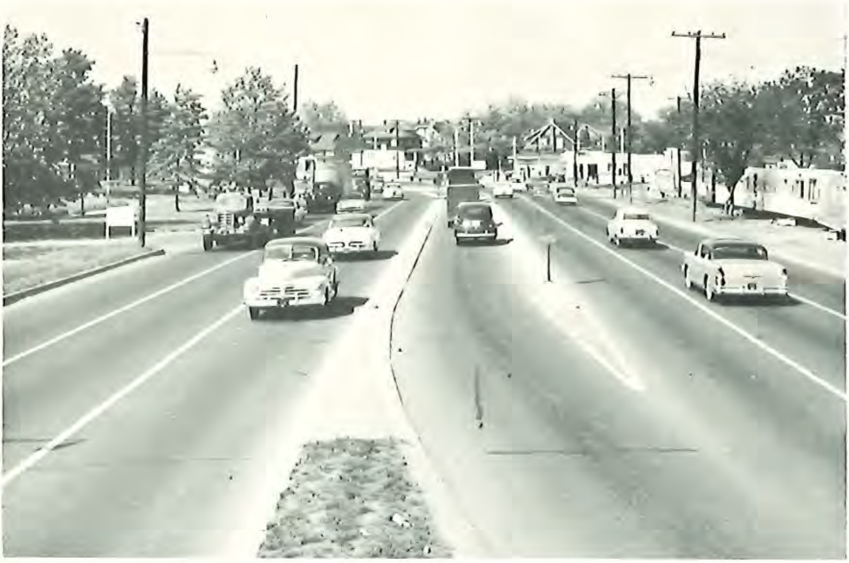

Figure 4–13. Median lane with mountable concrete curb traffic separators having a scored face for light reflection. Pavement markings and a hazard marker give advance warning of the introduced separator.

Divisional islands should be delineated as discussed in section 4A–3. Vertical curbs are required on medians where it is necessary to prohibit improper turning across the median area. On wide streets with heavy traffic volumes, curbed medians at least 4 feet wide are needed for pedestrian protection, as discussed in section 4B–3. Other narrow medians should be mountable and

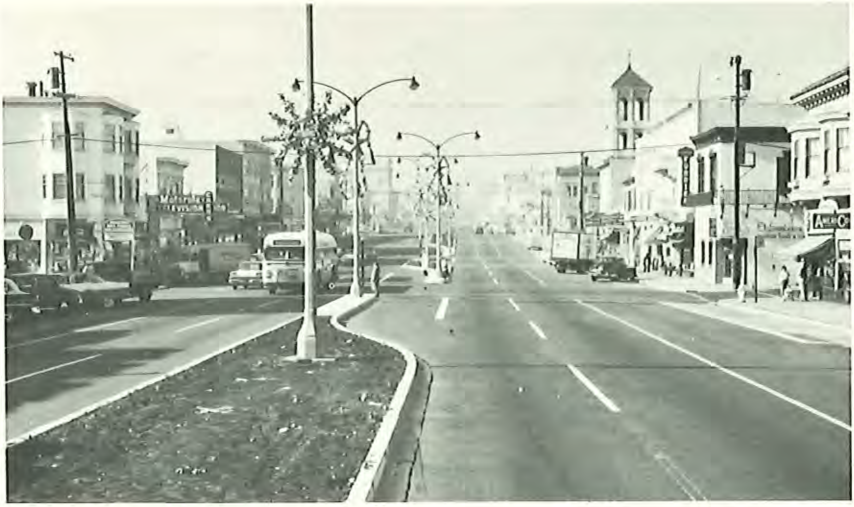

Figure 4–14. Separate left-turn lanes are notched into a relatively wide earth-filled median outlined with vertical curbs. The median lane separator is paved with concrete to serve as a pedestrian island.

may consist of low rolled curb sections with pavement filler, pavement markings, or a series of raised bars, corrugations, or buttons placed along the centerline. Flush medians of contrasting pavement color are also used. On streets where snow removal is frequent, low rounded or flush median sections are preferable (figs. 4–12, 4–16, and 4–17).

Approach-end treatment should be as described in section 4A–4. A divisional island should not be located so as to begin on a sharp curve or at the top of or just over a hillcrest where its presence in the roadway would introduce a surprise element to drivers.

Generally, divisional islands should not be placed where they will confine any part of the through roadway on either side to less than than two through traffic lanes, except when an island is used to separate through traffic from a left-turning median lane. Under extraordinary circumstances it may be advantageous to provide a divisional island with only a single through traffic lane alongside. The width of a through lane will be governed by the volume, type, and speed of traffic and other local conditions and may vary from 10 to 13 feet.

At some locations where indiscriminate pedestrian crossings would be hazardous on streets with fairly high vehicle speeds or where sizable pedestrian volumes in certain hours would disrupt traffic flow, it is advisable to consider erection of a pedestrian

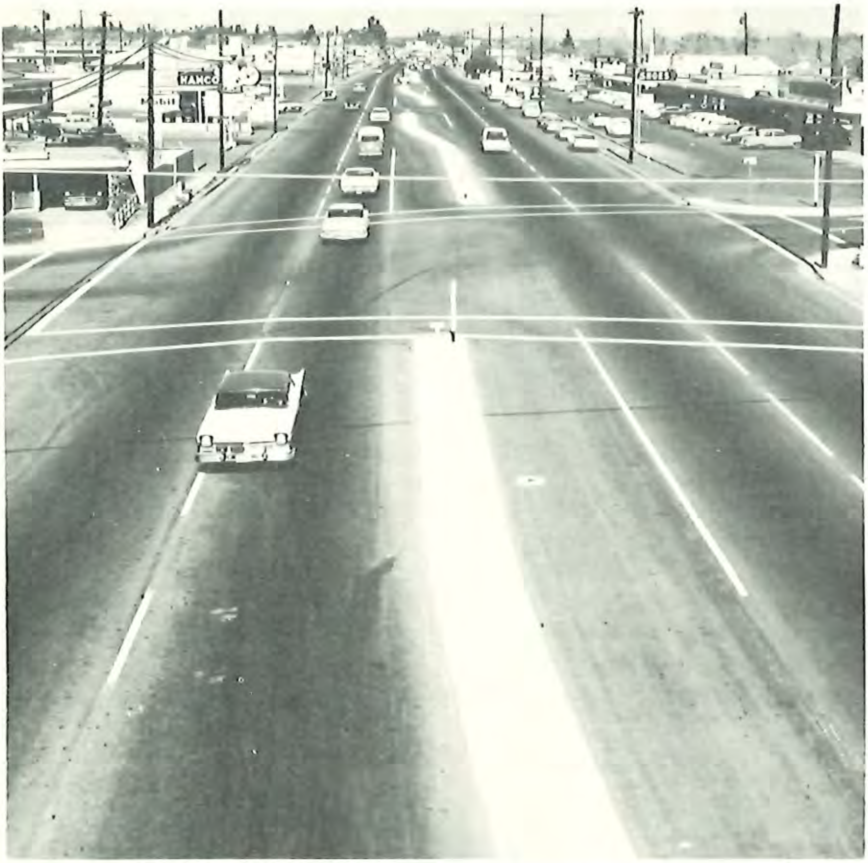

***Figure 4–15.** Raised concrete median warped to provide protection and storage for left-turning vehicles at intersections. Painted curbs and hazard markers mark the islands.*

barrier fence down the center of the divisional island. For clearance and maintenance, medians should be about 8 feet or more in width for such installations. The pedestrian barrier usually consists of some form of woven wire or picket fence and should be at least 3 feet high. It should extend the entire length between intersections, or for a distance of several hundred feet on either side beyond the point of pedestrian conflict. Such a pedestrian fence materially increases the visibility of the divisional island to the motorist and makes it a more effective traffic separator.

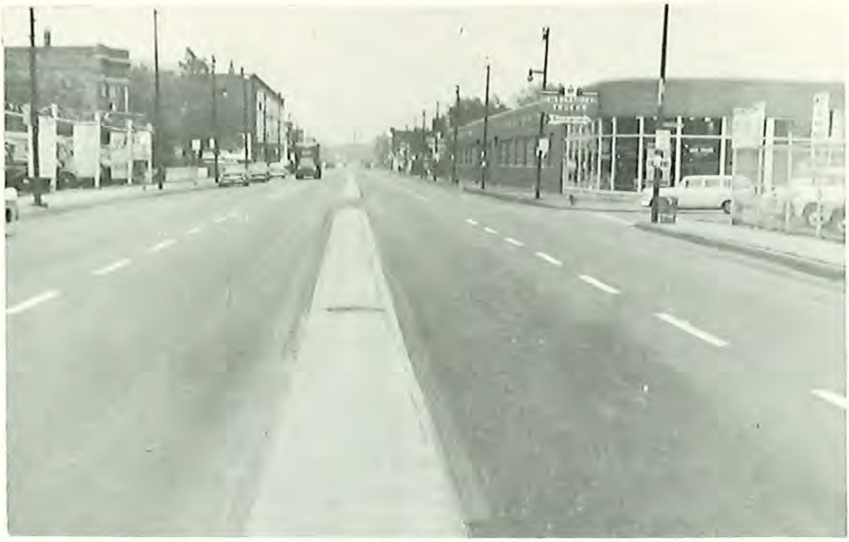

Figure 4–16. Low divisional island that can be crossed by vehicles but which discourages mid-block left turns.

4C–4 Illumination and Reflectorization

Divisional islands and the proper lanes of travel along them should preferably be made clearly visible at night through the use of adequate and well directed street lighting. If lighting facilities are not available, the island should be outlined as clearly as possible by the use of high-visibility approach-end devices as discussed in section 4A–4.

4C–5 Signs

A divisional island in the line of traffic flow shall be protected at the approach end by an appropriate reflectorized or illuminated sign or marker. An island with a width of 3 or more feet shall be protected with a regulatory Keep Right or a Double Arrow warning sign (secs. 1B–25, 1C–34). On islands narrower than 3 feet a reflectorized hazard marker (sec. 2D–2) shall be used. Such signs or markers should be set back from the island approach end to reduce the likelihood of being struck by a vehicle.

A continuous divisional island, except where very narrow or where defined by an unmountable curb, may also be protected by Keep Off Median signs (sec. 1B–37).

4C–6 Markings

The approach end of a divisional island in the line of traffic flow should be designed, signed, and marked to indicate its

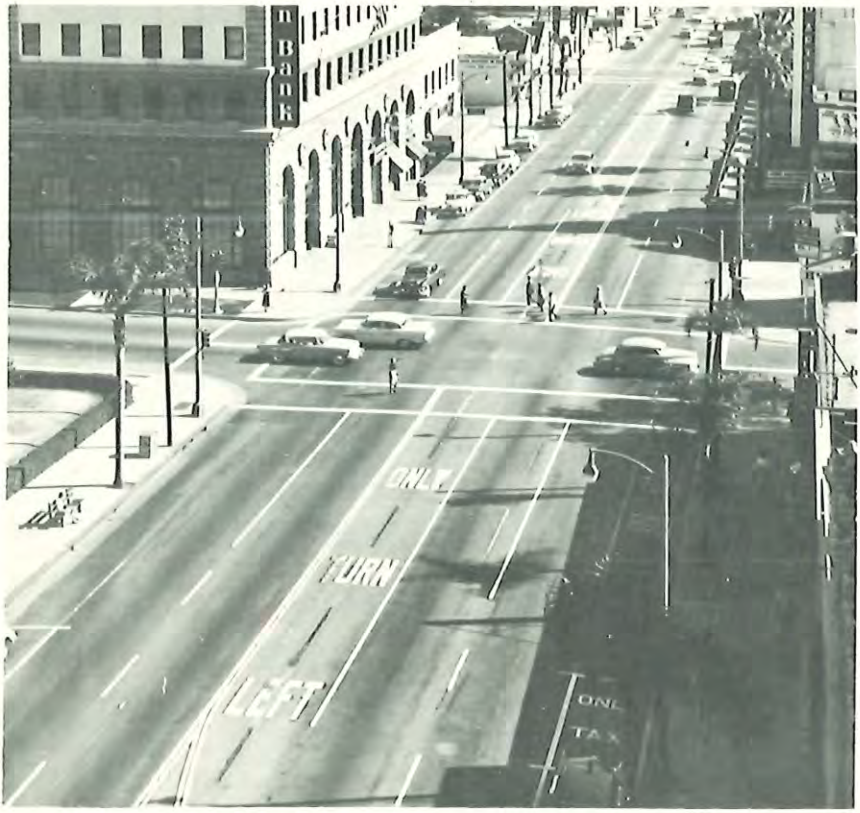

Figure 4–17. Continuous median designated by pavement markings, providing median lanes at every intersection.

presence and also to outline the proper vehicle paths. **Where necessary the approaches to such an island shall be marked in the manner provided for refuge islands** (secs. 4B–6, 2B–17 and 18, 2C–4).

D.—CHANNELIZING ISLANDS

Section 4D–1 Legal Authority

Channelizing islands are elements of street and highway design, and accordingly no special authority is required for their installation.

4D–2 Functions

The primary function of a channelizing island is to control and direct a motorist into the proper channel for his intended route and thus assure safe and efficient operation of the intersection. Channelizing islands are installed in areas that otherwise would be broad expanses of pavement, to bring about the desired orderly flow of traffic. As such the channelizing island primarily is a part of intersection layout design, the details of which are covered only in a general manner in this Manual.

4D–3 Specific Design Elements

The design of a channelized intersection can be decided only after special study of the particular area, it being a part of the whole intersection layout. The shape and size of the islands will vary widely according to the intersection conditions. For channelization of existing intersections it is desirable to test the layout by temporarily delineating the island area through the use of sandbags, stanchions, or markings before final construction. Reference should be made to chapter VII of the *Policy on Geometric Design of Rural Highways*[30] for design information. The number of channelizing islands used at any intersection should be kept to a minimum. The entire layout should be the simplest design that will accomplish the desired intersection control. Usually a few carefully placed islands of above-minimum size are more effective than a greater number of small islands which create multiple channels and cause confusion (figs. 4–18, 4–19).

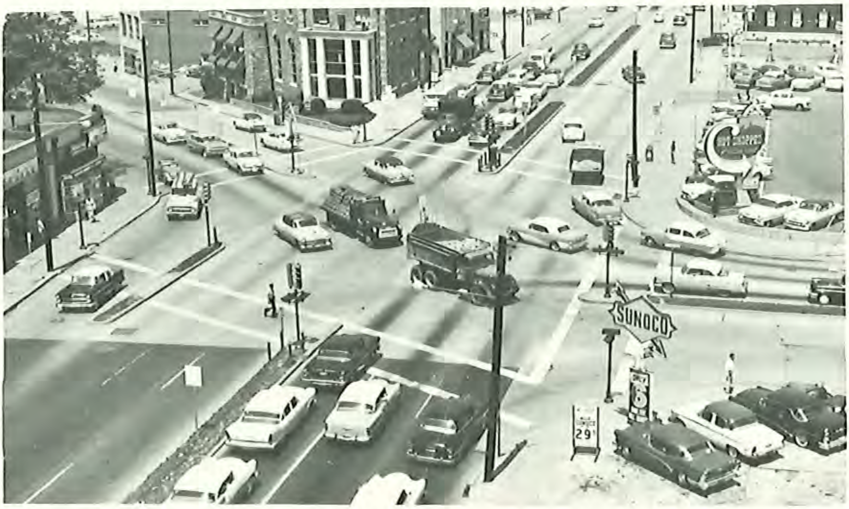

***Figure 4–18.* Channelized intersection of two major streets. The islands are paved within the crosswalk lines.**

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[30] Available from the American Association of State Highway Officials, 917 National Press Building, Washington 4, D.C.

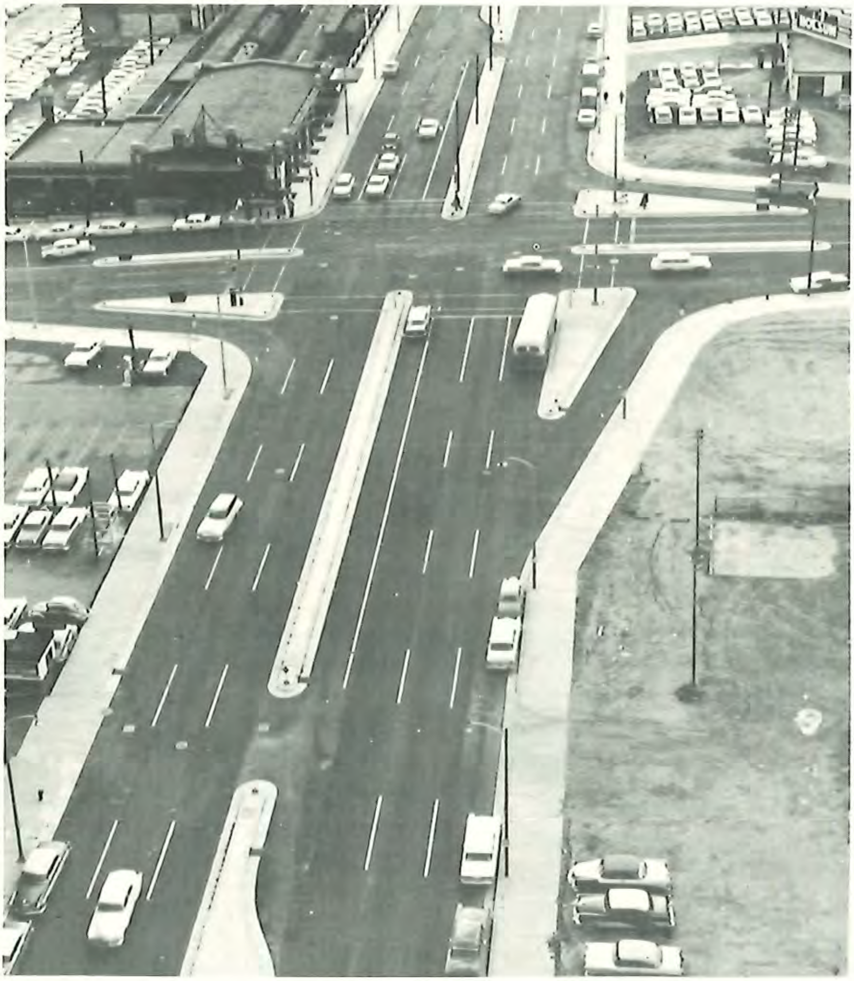

Figure 4–19. Channelizing islands at an intersection. The islands are concrete platforms outlined by curb and gutter. The width of the divisional islands is reduced to provide left-turn lanes at the intersection.

The general design elements discussed in section 4A–3 are applicable in determining the appropriate method for designation of a channelizing island. Curbed islands are most often used in urban areas, but pavement markings, raised bars, mushroom buttons, or other designation methods are often appropriate where encroachment on the island is not dangerous to motorists, pedestrians, or property (figs. 4–20, 4–21).

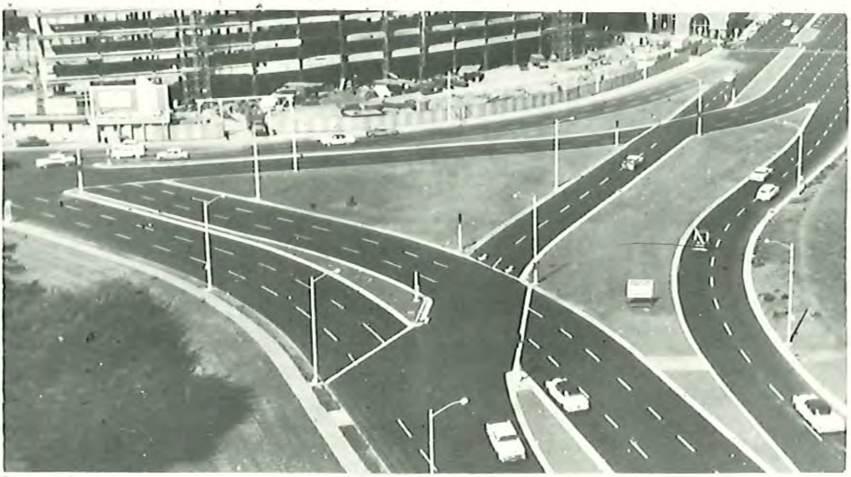

Figure 4–20. Channelized intersection with grass-covered islands outlined by high-visibility concrete curb and gutter. The design is supplemented by signalization, signs, pavement markings, and illumination.

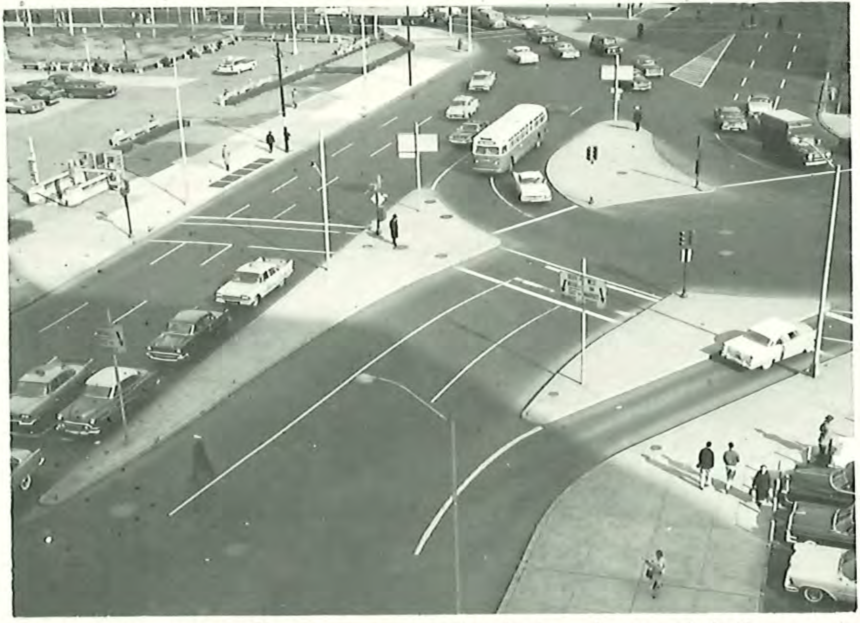

Figure 4–21. Channelization is accomplished through use of both concrete and painted islands in this intersection. The entire area is well illuminated.

Channelizing islands should be constructed with a color and texture of surface area contrasting with that of the adjacent pavement, and should be designed and located so that the proper travel paths are obvious, easy to follow, and unquestionably continuous (figs. 4–22, 4–23). Approach-end treatment should be as discussed in section 4A–4.

The lane widths provided through a channelized area should be in conformance with the pavement widths for separate turning lanes recommended in *A Policy on Geometric Design of Rural Highways,* as shown in table 8.

Table 8.—Design width of pavements for turning roadways[1]

	Case I: One-lane one-way operation, no provision for passing			Case II: One-lane one-way operation, with provision for passing a stalled vehicle			Case III: Two-lane operation, either one-way or two-way		
Pavement Width for Design Traffic Condition[2]									
	A	B	C	A	B	C	A	B	C
Radius on inner edge of pavement:	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*
50 feet	16	17	20	21	24	27	30	33	37
75 feet	15	16	18	20	22	25	28	31	34
100 feet	14	16	17	19	21	24	27	30	33
150 feet	13	15	16	18	20	23	26	29	31
200 feet	13	15	16	18	20	22	26	28	29
300 feet	12	15	15	17	19	21	25	27	28
400 feet	12	14	15	17	19	21	25	27	28
500 feet	12	14	15	17	19	21	25	27	27
Tangent	12	14	14	16	18	20	22	24	24
Width Modification According to Treatment of Edge of Pavement									
No stabilized shoulder	None			None			None.		
Mountable curb	None			None			None.		
Barrier curb:									
One side	Add 1 foot			None			Add 1 foot.		
Two sides	Add 2 feet			Add 1 foot			Add 2 feet.		
Stabilized shoulder, one or both sides	None			Deduct shoulder width; minimum pavement width as under Case I.			Deduct 2 feet where shoulder is 4 feet or wider.		

[1] Source: American Association of State Highway Officials, *A Policy on Geometric Design of Rural Highways*, 1954, table VII–7, p. 273.

[2] Traffic conditions: A.—Predominantly passenger vehicles but some consideration for single-unit trucks. B.—Sufficient single-unit vehicles to govern design, but some consideration for semitrailer vehicles. C.—Sufficient semitrailer vehicles to govern design.

4D–4 Illumination and Reflectorization

Channelizing islands and the proper lanes of travel along them preferably should be made clearly visible at night through the use of adequate and well directed street lighting. If lighting facilities are not available, the island should be outlined as clearly as

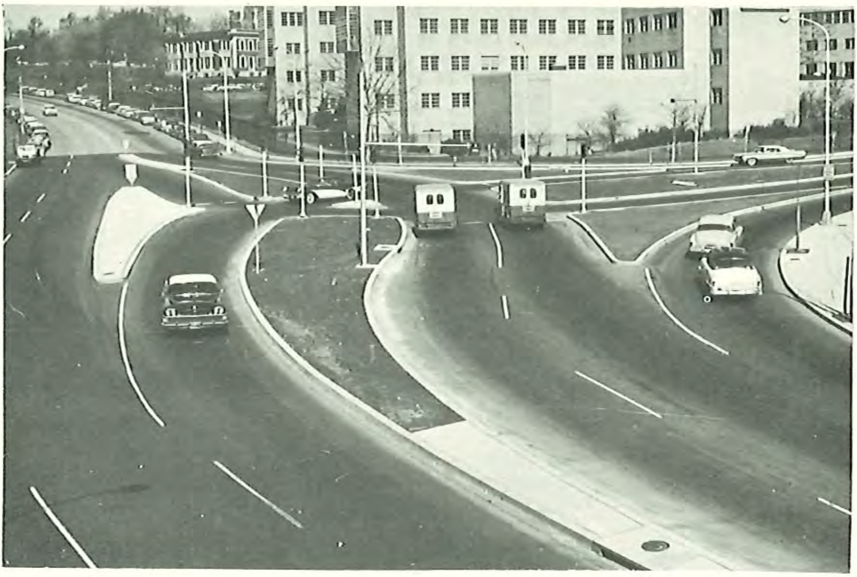

Figure 4–22. The smaller islands of this channelized intersection are of concrete, and the larger are of earth with concrete curb delineation.

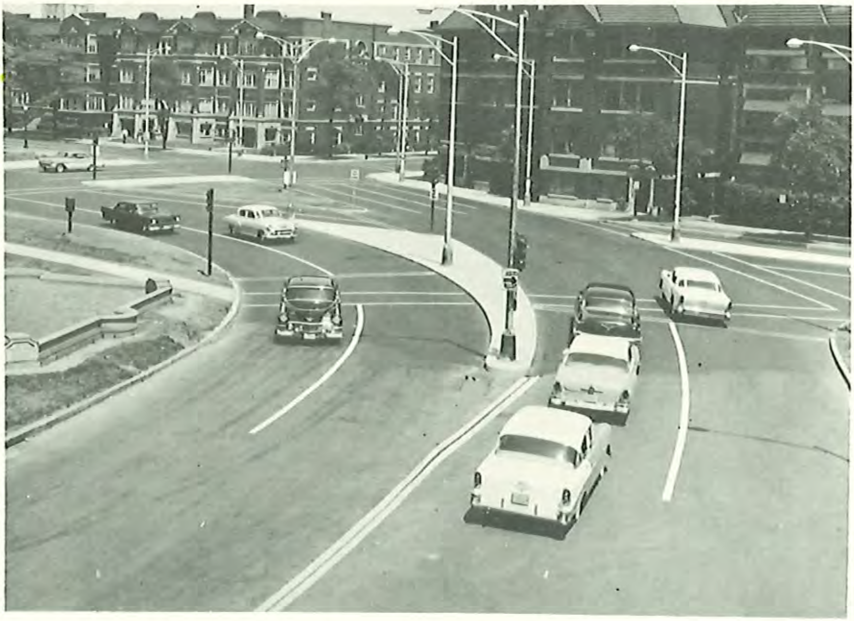

Figure 4–23. Channelization, signalization, and pavement markings are used to control movement within this intersection. The islands also serve as pedestrian refuge islands.

possible by the use of high-visibility approach-end devices (sec. 4A–4).

4D–5 Signs

Channelizing islands in the lines of traffic streams shall be protected at the approach ends by appropriate reflectorized or illuminated signs. As conditions require, a regulatory Keep Right sign (sec. 1B–25) or other appropriate signs should be used.

4D–6 Markings

The approach end of channelizing islands in the main streams of traffic flow should be marked to indicate their presence and also to outline the proper vehicle paths. The methods used are discussed in section 4B–6. Markings may not be necessary at secondary islands located within a multiple-island intersection. All markings should be in accordance with sections 2B–15, 17 and 18, and 2C–4.

Part V

TRAFFIC CONTROLS for HIGHWAY CONSTRUCTION and MAINTENANCE OPERATIONS

A—INTRODUCTION AND GENERAL SPECIFICATIONS

Section 5A-1 Need for Standards

Serious problems of traffic control occur under the special conditions encountered where traffic must be moved through or around road construction and maintenance operations. Such conditions are essentially temporary, but therefore the more dangerous and difficult to deal with because they are unexpected and not in accord with the normal pattern of highway traffic. Their record of accidents is convincing evidence of the need for the best protection possible.

Previous editions of this Manual have included a number of signs that are applicable to construction and maintenance operations—Men Working, Road Closed, and Detour, among others—but these have not always been sufficient, even in combination, nor have they been used consistently.

Obviously, no one standard sequence of signs or other control devices can be set up as an inflexible arrangement for all situations. Maintenance activities include such minor operations as shoulder mowing, tree trimming, and ditch clearing that may call only for a little extra care in driving, or some reduction in speed due to occasional encroachments on the traveled way. There may be other more tangible interferences in the form of standing or slowly moving equipment. Pavement patching or culvert repair may close parts of the roadway for extended periods, and a major job may reduce the traveled way to a single lane, over which vehicles must move alternately in one direction at a time. In the extreme case there is a complete closing of a road, with the diversion of traffic into a temporary routing.

Here is a range of requirements from the simplest sort of cautionary sign to the positive barricade. Even for the same job the necessary protection may vary from hour to hour and from day to day and particularly between day and night. Simple painted signs or barricades may be wholly sufficient by day, but at night such devices must be reflectorized and supplemented by torches, lanterns, flashers, or illumination. On the other hand, some maintenance work is discontinued at night, leaving the highway altogether unobstructed.

Numerous State highway departments and cities have drawn up their own standards, for use by their own construction and maintenance employees and by road contractors and public utility forces. With regard to traffic control devices they are in varying degrees consistent with this Manual. On a national basis the American Association of State Highway Officials approved in 1955, a *Policy on Maintenance of Safety and Traffic Control Devices and Related Traffic Services,*[31] which, with respect to traffic control devices, was in full accord with the then current edition of this Manual.

The following treatment of signs, signals, and markings for highway construction and maintenance work is intended to provide in effect a comprehensive handbook in its field, to be applied as a national standard. It establishes general principles to be observed in designing, installing, and maintaining traffic control devices on such work, and prescribes specific standards where possible. While it constitutes a part of this Manual, it is designed so that it can be used independently, for the convenience of those who are not concerned with the many other phases of traffic control. To that end some material concerning specifications and devices having more general application is repeated here from preceding parts of this Manual.

5A–2 Scope

This part sets forth basic principles and prescribes standards to be followed in the design, application, installation, and maintenance of all types of traffic control devices required for road construction and maintenance operations. Such devices include signs, signals, markings, barricades, and flagmen. Minimum standards of application are prescribed for typical situations, and methods of controlling traffic through work areas are described. As a part of these standards a number of typical situations are illustrated, showing the proper application of the standard protective devices.

These principles and standards are aimed at the protection of the public and workmen, the minimizing both of inconvenience to the public and of economic losses, and the maintaining of public good will.

Although these standards are basically applicable to both rural and urban situations, the specific provisions deal primarily with the problems normally found on rural highways. They are, however, equally suitable to high-speed controlled-access urban facilities, and with some modification to other urban facilities and to secondary highways. Applications to typically urban conditions are dealt with briefly in sections 5F–1 to 3.

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[31] Available from the American Association of State Highway Officials, 917 National Press Building, Washington 4, D.C.

5A–3 Application of Standards

Since it is not possible to prescribe detailed standards of application for all the situations that may conceivably arise, minimum standards are presented here for the most common situations. It is emphasized that these are minimum desirable standards for normal open highway situations and that additional protection must be provided where special complexities and hazards prevail, particularly on high-speed, expressway-type facilities. Where speeds and volumes are relatively low, where the hazard is clearly apparent, or where a maintenance operation is short in duration, less than the "minimum" protection prescribed for normal open highway conditions may be adequate. Although each situation must be dealt with individually, conformity with the provisions established herein is required. In particular situations not adequately covered by the provisions of this Manual, the protection of the traveling public, and of the workmen on the scene, will dictate the measures to be taken, consistent with the general principles set forth herein.

5A–4 Responsibility

The provisions for public protection established herein are for application by (1) State highway department, county, and municipal forces performing construction or maintenance operations on roads and streets, (2) contractors employed in road construction or maintenance under contract to any governmental authority, and (3) all others, including employees of public utility companies, performing any work on highways or so closely adjacent as to create hazards for the public or for themselves.

These standards, as a part of the Manual on Uniform Traffic Control Devices, should be adopted by all public authorities concerned with highways, and should be given effect by official instructions to employees and by incorporation into the specifications for all contracts. Responsible officials should at all times maintain such supervision as to assure that protective devices will meet at least the minimum standards herein set forth.

It is important that the authorities having jurisdiction be able to require proper protection, that responsibility be clearly assigned, and that there be adherence to the standards and provisions of this Manual.

5A–5 General Requirements

1. All traffic control devices used on road construction or maintenance work shall conform to the applicable specifications of this Manual.

2. Traffic control devices shall be set up prior to the start of construction or maintenance operations, and shall be properly maintained during the time such special conditions exist. They shall remain in place only as long as they are needed and shall be immediately removed thereafter. Where operations are performed in stages, there shall be in place only those devices that apply to the conditions present during the stage in progress. Signs such as MEN WORKING or FLAGMAN AHEAD shall be covered or set aside out of the view of traffic at times when they do not apply.

5A–6 Maintenance of Traffic Control Devices

In order to function most efficiently and retain their authority, traffic control devices must be well maintained. Deteriorated traffic control devices command little respect and lose effectiveness.

Signs shall be kept in proper position, clean, and legible at all times. Signs that do not apply to existing conditions shall be removed. Damaged, defaced, or dirty signs shall be cleaned, repaired, or replaced.

Barricades and sign supports shall be neatly constructed and shall not appear makeshift or hastily thrown together. They shall be repaired and cleaned or repainted as needed to keep up their appearance.

Oil-burning torches and lanterns shall not be placed so close to signs or barricades as to scorch them or deposit soot on them. Lantern globes shall not be allowed to become smoked or sooted. Special care shall be taken to see that weeds, shrubbery, construction materials or equipment, spoil, and snow are not allowed to obscure any sign, light, or barricade.

B—SIGNS

General

Section 5B–1 Design of Signs

Highway construction and maintenance signs fall into the same three major categories as do other traffic signs, namely, Regulatory signs, Warning signs, and Guide signs. Many signs normally used elsewhere will also find application for road work. Special construction and maintenance signs follow the basic standards for all highway signs as to shape and color prescribed elsewhere in this Manual.

The use of stripes (other than the standard border) or other geometric patterns or contrasting colors on or around any sign in an attempt to make it more conspicuous distracts attention from the message and defeats the purpose of maintaining uniformity and simplicity of design. Such practice is contrary to standards and is accordingly disapproved. However, the use of red flags in conjunction with signs is permitted, so long as they do not interfere with a clear view of the sign face.

The dimensions of signs shown herein are for standard sizes, which should be increased wherever necessary for adequate control and safety. On minor highways and secondary streets smaller signs may be used if authorized by competent authority.

Standard sign sizes and colors are here shown in the illustrations of the individual signs rather than in detailed specifications in the text.[32]

5B–2 Illumination and Reflectorization

All signs that are to convey their messages during hours of darkness shall be reflectorized or illuminated.

Where there is serious interference from extraneous light sources and a reflectorized installation is not likely to give effective performance, an illuminated sign should be used. Sign illumination may be either internal or external. External illumination may be provided by incandescent or fluorescent lamps, or spotlights. Lamps should be properly shielded to protect drivers from glare. Torches or lanterns are for warning or guidance in themselves, and are not considered adequate for the purpose of sign illumination. Street or highway lighting is not regarded as meeting the requirements for sign illumination.

5B–3 Position of Signs

Signs must always be placed in positions where they will convey their messages most effectively without restricting lateral clearance or sight distance. Placement must therefore be accommodated to highway design and alinement. Signs must be so placed that the driver will have sufficient time to absorb the message before having to act.

As a general rule signs shall be located on the right-hand side of the roadway, with the near edge of the sign from 6 to 12 feet from the edge of the traveled way or at least 2 feet outside an unmountable curb. Where construction or maintenance operations are underway, however, it is often necessary to place signs on barricades within the roadway, or (usually as supplementary or duplicate signs) on the left of the roadway. All signs should be mounted approximately at right angles to the direction of and facing the traffic they are to serve. Roadside signs should be mounted so that the bottom of the sign is approximately 5 feet above the pavement level. Where construction equipment or materials, or other obstructions, may be present this height should be increased to 7 feet. Standards for height and lateral clearance of roadside signs are shown in figure 5–1. Signs mounted on barricades, or temporary signs in the roadway, may be at lower heights as dictated by circumstances (fig. 5–2).

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[32] Detailed working drawings of the signs specified herein are available on request from the Bureau of Public Roads.

Regulatory signs are normally placed at the point where the regulations apply.

Where normal open highway speeds prevail on the approach to the work site, advance warning signs should be placed at least 750 feet in advance of the condition to which they are calling attention. Where a series of advance warning signs are used, the warning sign nearest the work site should be placed 500 feet from the point of restriction with the additional signs at 500-foot intervals. Where prevailing speeds are low in the approach to the hazardous area, signs may be placed at 300-foot spacings in the immediate vicinity of the work, and at even closer spacings in urban areas. On high-speed expressway-type facilities the advance warning distance should be increased to one-half mile or more. Typical sequences and spacings of advance warning signs are shown in figures 5–5 to 5–11.

5B–4 Erection of Signs

Signs are usually mounted on a single post, although those wider than 48 inches or larger than 10 square feet in area should generally be mounted on two posts.

The Road Closed sign (sec. 5B–8) is normally mounted on the barricade that closes the road. The Advisory Speed plate, when used, is erected only in conjunction with a warning sign as prescribed in section 5B–34.

For maximum mobility on certain types of maintenance operations, a large sign may sometimes be effectively mounted on a vehicle stationed in advance of the work or moving along with it. This may be the working vehicle itself, as in the case of shoulder-mowing or paint-striping equipment.

Guide signs, although ordinarily erected on posts, may also be mounted on or above barricades, but should not be permitted to interfere with the effectiveness of necessary regulatory and warning signs.

Typical methods of mounting signs other than on posts are shown in figure 5–2.

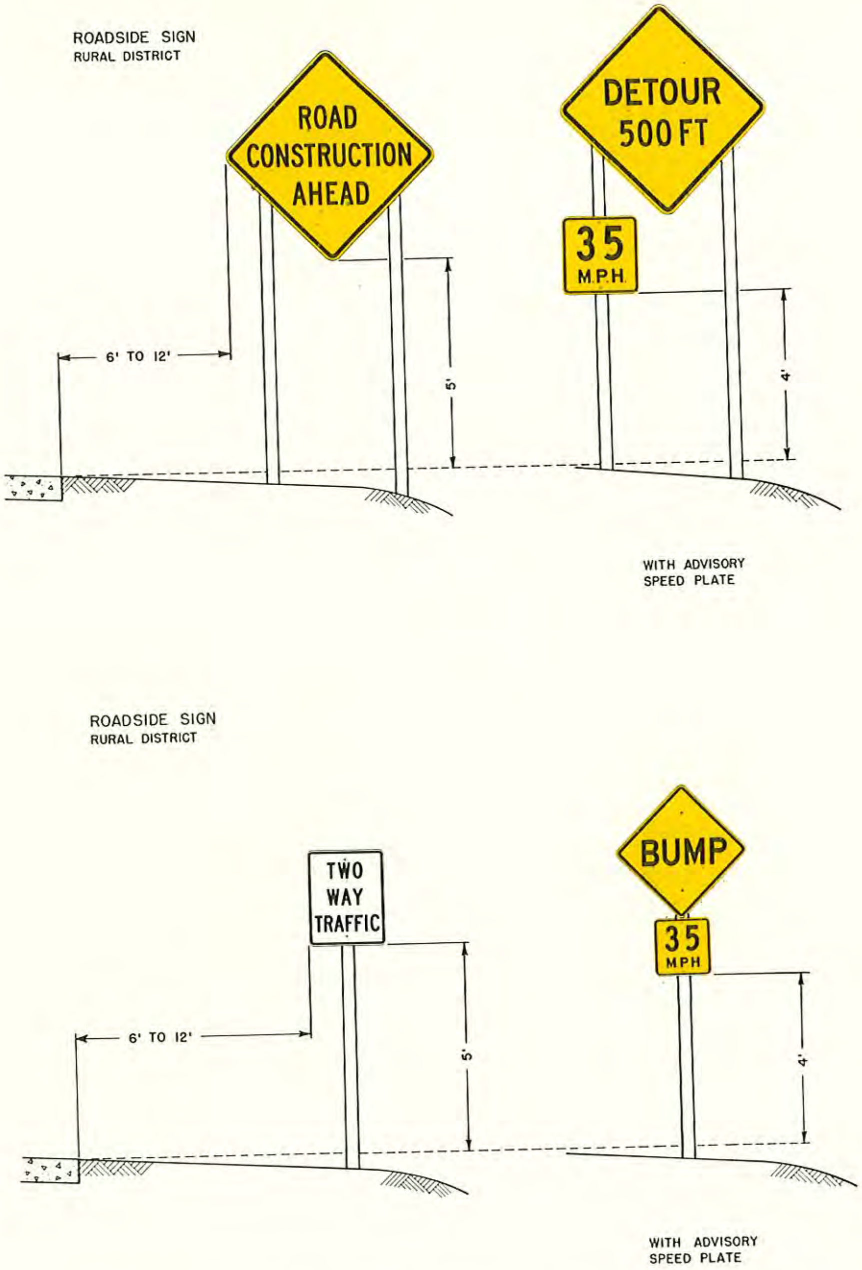
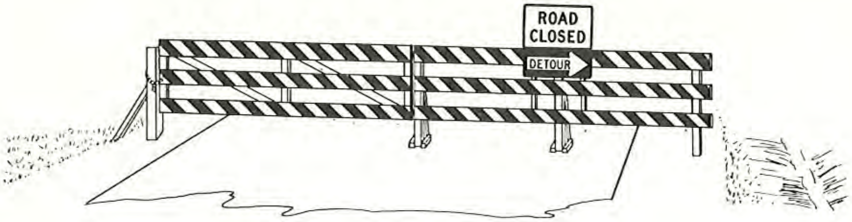
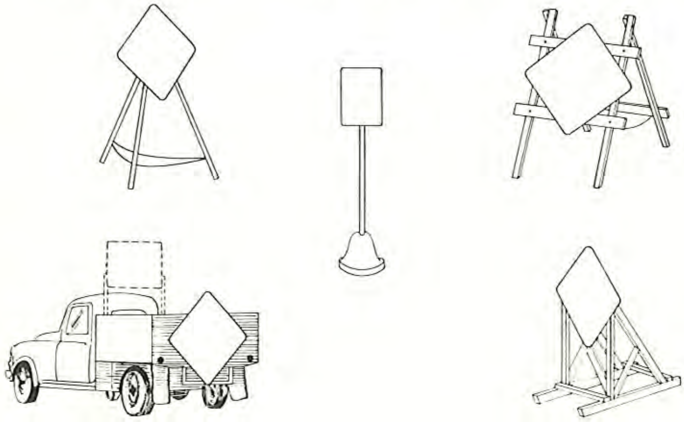

ROADSIDE SIGN
RURAL DISTRICT
ROAD CONSTRUCTION AHEAD
DETOUR 500 FT
35 M.P.H.
6' TO 12'
5'
4'
WITH ADVISORY SPEED PLATE
ROADSIDE SIGN
RURAL DISTRICT
TWO WAY TRAFFIC
BUMP
35 MPH
6' TO 12'
5'
4'
WITH ADVISORY SPEED PLATE

Figure 5–1. Height and lateral location of signs—typical installations.

BARRICADE CLOSING A ROAD


ROAD
CLOSED
DETOUR

PORTABLE AND TEMPORARY MOUNTINGS



WING BARRICADES

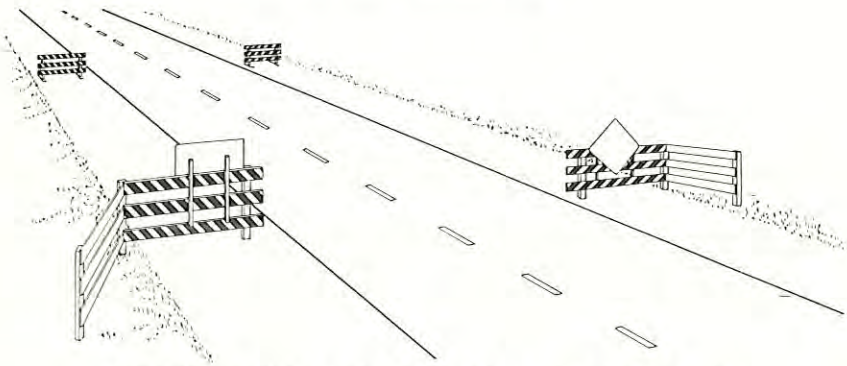


Figure 5–2. Methods of mounting signs other than on posts.

Section 5B–5 Authority

Regulatory signs impose legal compulsions or restrictions on drivers. **It is essential, therefore, that their use be officially authorized and that they conform to the standards officially adopted by the authorities having responsible jurisdiction.**

5B–6 Design of Regulatory Signs

Regulatory signs are generally rectangular with their longer dimension vertical, and carry a black legend and border on a white background. There are, however, exceptions. The Stop sign is octagonal, and has a white legend and border on a red background. The Yield sign is a yellow inverted triangle with black legend and border. The One Way sign may be either a horizontal or a vertical rectangular plate, the latter being used more commonly in cities where space is limited. The Road Closed sign is usually mounted on a barricade, and its greater horizontal dimension is appropriate to such an application.

For regulatory signs 30 inches by 36 inches in size, or larger, white legend on a black background may be used.

5B–7 Application of Regulatory Signs

Construction and maintenance operations are usually temporary in duration, rarely warranting special official traffic control measures. Provisional control of traffic will ordinarily be accomplished through warning signs, while existing regulatory signs will usually remain in place. Control of speed through a construction or maintenance zone may be achieved by Advisory Speed plates (sec. 5B–34) in conjunction with warning signs. Passing can be discouraged by warning signs or channelization. One-way traffic can usually be directed by barricades, arrow signs, or flagmen.

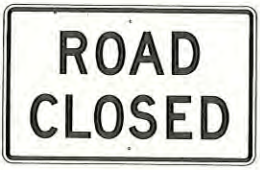
A few standard regulatory signs, however, are necessary at times, the use of which must be officially authorized. Temporary intersections or intersections having temporarily altered traffic patterns may require Stop signs or Yield signs. Certain roadways may temporarily require One Way signs, Do Not Enter signs, or Do Not Pass signs. On long detours over existing roads it may be necessary to install additional controls of standard type to handle the augmented traffic. At some projects where traffic is maintained through the work site for an appreciable distance, it may be desirable in the interest of safety for the responsible authority to establish and post a legal maximum speed limit applicable throughout the entire section. Warning signs with Advisory Speed plates should then be posted at those locations where the safe speed is lower than the imposed legal limit.

Regulatory signs of special importance for road work are the Road Closed sign, the Local Traffic Only sign, the Weight Limit sign, and signs calling attention to two-way operation.

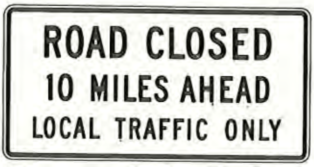
5B–8 Road Closed Sign (R10–2)

The ROAD CLOSED sign shall be used where the road is closed to all traffic except contractors' equipment and officially authorized vehicles. It should be erected at or near the center of the roadway on or above a Class I barricade (sec. 5C–3). Because it is the last sign the driver will see before he must stop or turn it is essential that it be large and legible. **It shall have a standard, and minimum, size of 48 inches by 30 inches.**

The Road Closed sign shall not be used where traffic is maintained or where the actual closure is some distance beyond the sign and local traffic is permitted access to nearer points. In the latter case the Local Traffic Only sign (R10–3) must be used (sec. 5B–9).



R10–2
48" x 30"



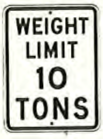
R10–3
60" x 30"

5B–9 Local Traffic Only Sign (R10–3)

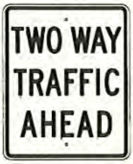
The Local Traffic Only sign shall be used where through traffic must detour to avoid a closing of the highway at a construction or maintenance job some distance beyond, but where the highway is open for traffic up to the point of closure. It carries the legend ROAD CLOSED (10) MILES AHEAD—LOCAL TRAFFIC ONLY. It should be erected at the right of the roadway or, preferably, on a narrow barricade in the center of the roadway if the pavement width permits. Normally it will be accompanied by a Detour Arrow sign (sec. 5B–39) indicating the proper route for through traffic. The words BRIDGE OUT may be substituted for ROAD CLOSED where applicable. **Where the sign faces through traffic it shall be preceded by an Advance Road Closed sign with the secondary legend AHEAD (sec. 5B–21) and, if applicable, an Advance Detour sign (sec. 5B–20).**

5B–10 Weight Limit Sign (R10–4)

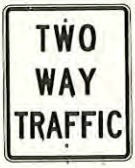
The Weight Limit sign shows the maximum gross weight of a vehicle that can safely be permitted on a road surface or bridge. Weight restrictions should not be imposed without the approval of the authority having jurisdiction over the highway, and a reasonable effort should be made to provide temporary facilities capable of carrying the traffic normally using the highway.



R10–4
18″ x 24″



R6–3
24″ x 30″



R6–5
24″ x 30″

5B–11 Two Way Traffic Ahead Sign (R6–3)

The TWO WAY TRAFFIC AHEAD sign shall be used on a one-way roadway just in advance of a point where it becomes a two-way roadway. It may be supplemented by Keep Right or arrow signs, barricades, or other channelizing devices.

5B–12 Two Way Traffic Sign (R6–5)

The TWO WAY TRAFFIC sign is intended for use where a roadway designed or normally used for one-way traffic is temporarily being used for traffic in both directions, or where under any other circumstances it may be necessary to remind drivers that they are traveling on a two-way roadway. The sign should be placed at intervals of about one-half mile, but not exceeding one mile. Special care must be taken to place it at or just beyond any important access points.

5B–13 Special Regulatory Signs

Various other regulatory or quasi-regulatory signs may be called for by special operations in or around the roadway. Although it is not practicable to standardize many such signs in detail, they should conform to the general standard of a rectangular shape with a black legend on a white background. Their messages should be brief, legible, and clearly understandable. Typical examples are: KEEP OFF WET PAINT; BLASTING ZONE (or AREA)—TURN OFF 2-WAY RADIO (or NO RADIO TRANSMISSION); and NO STOPPING.

Warning Signs

Section 5B–14 Function of Warning Signs

Warning signs are the most important type of signs used to protect traffic, equipment, and workmen where road construction or maintenance operations are underway. Within the construction zone there may be various temporarily substandard facilities, where roadway width is reduced, a detour is necessary, open excavations are present in or near the roadway, or an unpaved section must be traversed. If drivers are properly alerted to possible dangers ahead and so reduce their speed to meet the anticipated hazards, they will be able to deal with whatever special conditions are present.

Many warning signs that may be required for road construction and maintenance operations are identical with those used for similar hazards elsewhere on the highway. In fact, almost every standard warning sign may at one time or another be needed on a construction or maintenance job or on detours temporarily provided.

5B–15 Design of Warning Signs

With few exceptions standard warning signs are diamond-shaped (square, with one diagonal vertical), having a black symbol or message on a "highway yellow" background. For the unexpected hazards caused by major road construction work it is important that the advance signs, at least, be of large size, for maximum visibility and legibility.

Where extensive or unusually hazardous construction or maintenance operations are to take place on major freeway or expressway facilities, extraordinarily large warning signs may be needed. Under some such conditions practical considerations may justify departure from the standard diamond shape, but such variances should have prior approval of the appropriate highway authority. **Such special warning signs may carry other than the standard messages, but they shall conform otherwise to the design standards for warning signs. This provision shall not be construed as permitting either a general use of rectangular warning signs or deviations from the standard messages where standard messages are applicable.**

As a special exception the warning signs described in sections 5B–27 to 32 may be square when they are mounted on, or as a part of, a small portable easel, for frequent moving on minor maintenance operations.

The standard Advisory Speed warning plate is square for convenience in mounting it in conjunction with other warning signs.

Detailed specifications are here given only for the signs especially prescribed for construction and maintenance work and for a few other standard signs that are commonly required for similar application.

5B–16 Dimensions of Warning Signs

The standard sizes of warning signs shall be as shown with the sign illustrations herein. Where the messages of Construction Approach Warning signs (sec. 5B–17) are required at maintenance or minor construction sites, and where speeds and volumes are relatively low, they may be on 36-inch plates, provided that a minimum letter size of 5 inches can be accommodated on the plate.

Similarly, on minor roads or secondary streets where speeds are low, or where traffic has already been slowed by Construction Approach Warning signs, the use of plates 6 inches smaller on a side than the standard size, but not less than 24 inches, may be justified for other warning signs having short word messages or clear symbols.

If there is any question whether the standard size will be sufficiently conspicuous or legible, enlarged signs should be used.

5B–17 Construction Approach Warning Signs

Where major construction or maintenance is under way on a rural highway and any part of the roadway is obstructed or closed, it is necessary to give special advance warning, and for this purpose a series of Construction Approach Warning signs is provided in the following sections. **Because of their importance these signs shall have a standard size of 48 inches by 48 inches. They shall be of the standard diamond shape for warning signs, except as provided for in section 5B–15.**

5B–18 Application of Construction Approach Warning Signs

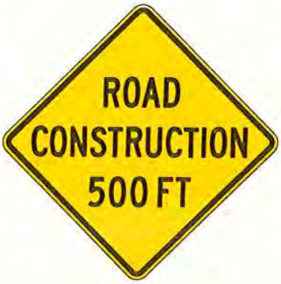
Construction Approach Warning signs are for the purpose of alerting traffic, well in advance, to serious obstructions or restrictions due to road work. In rural areas where space permits there should be at least three such signs, at 500, 1,000, and 1,500 feet, respectively, in advance of the point of restriction, erected as provided for in sections 5B–3 and 5B–4. These signs may be any appropriate combination of, or repetition of, the several approach signs (secs. 5B–19 to 25) or other suitable standard warning signs, typical applications of which are shown in figures 5–5 to 5–11. The advance distances specified are for relatively high-speed rural areas, and should be modified as necessary, as provided in section 5B–3.

It is recognized that circumstances may occur which will not warrant the erection of these signs at specific advance distances, particularly where the work may not remain fixed at a definite point. The indication of an exact distance can be misleading or undesirable in cases where the restriction occurs in advance of the actual work-site, or where the first warning sign is of a general nature and more attention is desired for subsequent, more specific, signs. If it is not practical to indicate exact distances, the secondary legend AHEAD may be substituted for the distance expressed in feet, though it should not be used so far in advance as to lose significance. The secondary messages may be inserted by stenciling or by attaching a panel to the face of the sign.

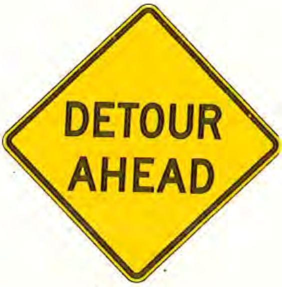
Construction Approach Warning signs should be mounted on two posts, from 6 to 12 feet from the pavement edge (secs. 5B–3, 5B–4) or on wing barricades (sec. 5C–3), at appropriate advance distances. Where traffic is heavy, particularly on one half of a divided highway, the signs should be erected on both sides of the roadway.

5B–19 Advance Road Construction Sign (W20–1)

The Advance Road Construction sign is intended for use in advance of road construction projects as a general warning of possible obstructions or restrictions due to such work. It carries the legend ROAD CONSTRUCTION, followed by 1500 FT (W20–1a), 1000 FT (W20–1b), 500 FT (W20–1c), or AHEAD (W20–1d). Following its erection at 1,500 feet, it may be erected also at 1,000 feet and at 500 feet, or the more specific messages of other Construction Approach Warning signs may be used as may be appropriate.



W20–1c
48" x 48"



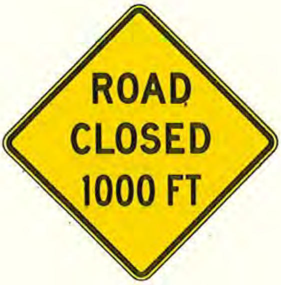
W20–2d
48" x 48"

5B–20 Advance Detour Sign (W20–2)

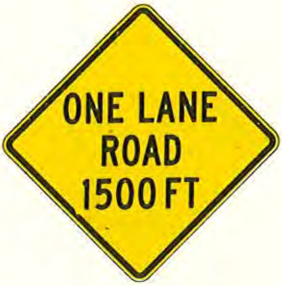
The Advance Detour sign is intended for use in advance of a point at which traffic is diverted over a temporary roadway or route. It carries the legend DETOUR, followed by 1500 FT (W20–2a), 1000 FT (W20–2b), 500 FT (W20–2c), or AHEAD (W20–2d). It may be used in repetition or in combination with other appropriate Construction Approach Warning signs.

5B–21 Advance Road Closed Sign (W20–3)

The Advance Road Closed sign is intended for use in advance of a point at which a roadway is closed to all traffic, or to all but local traffic. It carries the legend ROAD CLOSED, followed by 1500 FT (W20–3a), 1000 FT (W20–3b), 500 FT (W20–3c) or AHEAD (W20–3d). It will normally be used in conjunction with other Construction Approach Warning signs, but where a local road is closed without provision of a detour it may be repeated at all three distances. **In such a case there shall be erected, at the last preceding intersection where a detour is possible, the Local Traffic Only sign (sec. 5B–9).**



W20–3b
48" x 48"



W20–4a
48" x 48"

5B–22 Advance One Lane Road Sign (W20–4)

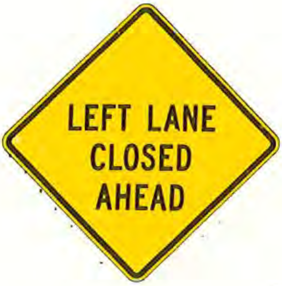
The Advance One Lane Road sign is intended for use only in advance of a point where traffic in *both* directions must use a single lane (sec. 5E–7). It carries the legend ONE LANE ROAD, followed by 1500 FT (W20–4a), 1000 FT (W20–4b), 500 FT (W20–4c), or AHEAD (W20–4d). It may be used in repetition or in series with other Construction Approach Warning signs.

If the one-lane stretch is of such length as not to be visible throughout from either end, or if the traffic is of such volume that simultaneous arrivals at both ends occur frequently, provision must be made to permit traffic to move alternately under control (secs. 5E–7 to 11).

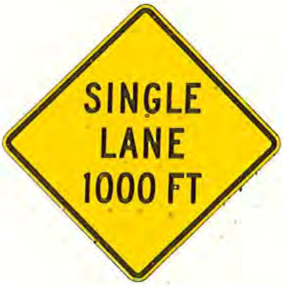
5B–23 Advance Lane Closed Sign (W20–5)

The Advance Lane Closed sign is intended for use where applicable in advance of a point where one lane of a multiple-lane roadway is closed (secs. 5E–1, 2). It carries the legend RIGHT (or LEFT) LANE CLOSED, followed by 1500 FT (W20–5a), 1000 FT (W20–5b), 500 FT (W20–5c), or AHEAD (W20–5d). This sign may be used in repetition or in series with other Construction Approach Warning signs.

For construction and maintenance operations, where the closing of a traffic lane is not only unexpected but may be masked by the presence of existing pavement markings or delineators, the Lane Closed sign is preferred to the standard Pavement Width Transition symbol sign (sec. 1C–21). An appropriate standard symbol may be used, however, with the permission of the proper authority.



W20–5d
48" x 48"



W20–6b
48" x 48"

5B–24 Advance Single Lane Sign (W20–6)

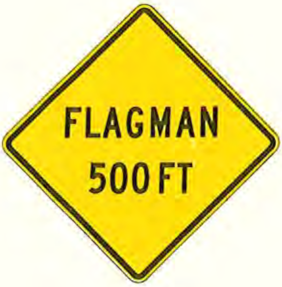
The Advance Single Lane sign is intended for use in advance of a point where traffic moving in one direction must use a single lane. It carries the legend SINGLE LANE, followed by 1500 FT (W20–6a), 1000 FT (W20–6b), 500 FT (W20–6c), or AHEAD (W20–6d). It may be used in repetition or in series with other Construction Approach Warning signs, particularly the Lane Closed sign.

This sign shall not be used where traffic in both directions must use the one lane that is open.

5B–25 Advance Flagman Sign (W20–7)

The Advance Flagman sign shall be used in advance of any point at which a flagman has been stationed to control traffic

through a construction or maintenance project. It carries the legend FLAGMAN, followed by 1500 FT (W20–7a), 1000 FT (W20–7b), 500 FT (W20–7c), or AHEAD (W20–7d). It will normally be preceded by other Construction Approach Warning signs, but may be repeated at any or all of the indicated distances.



W20–7c
48″ x 48″

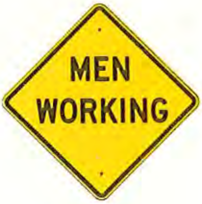
It may be for relatively permanent or temporary use. In the former case it should be on a fixed mounting. If the flagging operation is to be of short duration a portable support should be used, or a temporary attachment to a wing barricade (secs. 5C–5, 6). **The sign shall be promptly removed, covered, or turned to face away from the roadway whenever the flagman is not at his station.**

5B–26 Maintenance and Minor Construction Warning Signs

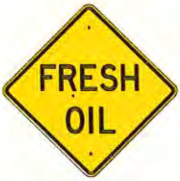
At many maintenance and minor construction operations, particularly on lightly traveled roads, there may be no need for the sequence of Construction Approach Warning signs prescribed for major operations. The signs described in the following sections will ordinarily provide sufficient advance warning in such situations, either by themselves or in combination with appropriate Construction Approach Warning signs, as dictated by conditions. In addition, some of them may be needed inside the limits of a major work area where traffic is maintained through the job.

5B–27 Men Working Sign (W21–1)

The MEN WORKING sign shall be used in conjunction with minor maintenance and public utility operations for the protection of men working in or near the roadway. Where there is any obstruction in the traveled way, other appropriate warning signs and devices as described herein should be used. In low-speed urban areas the Men Working sign may be used at limited obstructions which are adequately marked and clearly visible, such as an open manhole with a fence around it.



W21–1
30″ x 30″



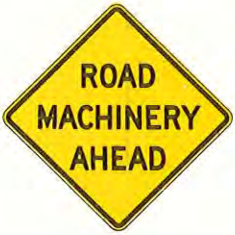
W21–2
24″ x 24″

5B–28 Fresh Oil Sign (W21–2)

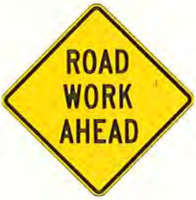
The FRESH OIL (or FRESH TAR) sign shall be used to warn motorists that resurfacing operations have rendered the surface of the pavement temporarily hazardous, and that objectionable splashing on vehicles may occur.

5B–29 Road Machinery Ahead Sign (W21–3)

The ROAD MACHINERY AHEAD sign shall be used in areas where heavy road equipment, such as a grader, is operating in or closely adjacent to the roadway.



W21–3
36″ x 36″



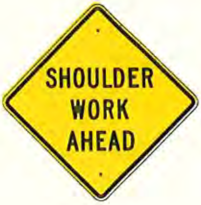
W21–4
30″ x 30″

5B–30 Road Work Ahead Sign (W21–4)

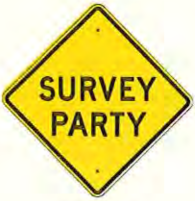
The ROAD WORK AHEAD sign is intended for use in advance of maintenance or minor reconstruction operations in the roadway (fig. 5–10).

5B–31 Shoulder Work Ahead Sign (W21–5)

The SHOULDER WORK AHEAD sign is intended for use in advance of maintenance or minor reconstruction operations involving the shoulder, where the traveled way remains unobstructed.



W21–5
30″ x 30″



W21–6
30″ x 30″

5B–32 Survey Party Sign (W21–6)

The SURVEY PARTY sign is intended for use in advance of a point where a surveying party is working in or closely adjacent to the roadway.

5B–33 Other Warning Signs

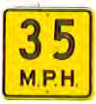
In addition to the warning signs specifically related to construction and maintenance operations there are numerous other warning signs, standardized for general use and treated in part I of this Manual, that may find application in work areas. These include the following:

Large Arrows (W1–6, 7, sec. 1C–9).
Road Narrows (W5–1, sec. 1C–19).
Divided Highway Ends (W6–2, sec. 1C–23).
Bump (W8–1, sec. 1C–25).
Dip (W8–2, sec. 1C–26).
Pavement Ends (W8–3, sec. 1C–27).
Soft Shoulder (W8–4, sec. 1C–28).
Truck Crossing (W11–1, sec. 1C–33).
Loose Gravel (sec. 1C–37).
Rough Road (sec. 1C–37).
Falling Rock (sec. 1C–37).
Low Shoulder (sec. 1C–37).

The application of most of these signs is prescribed in detail in part I of this Manual, but is generally apparent from their legends.

5B–34 Advisory Speed Plate (W13–1)

In conjunction with any warning sign, and only in combination with a warning sign, an Advisory Speed plate (sec. 1C–36) may be used to indicate a suitable safe speed through the hazardous area. The speed shown on the plate is not intended as an enforceable limit. The Advisory Speed plate should show, in multiples of 5 miles per hour, a reasonable speed for normal conditions of weather and lighting. Too low a speed indication will be ignored and breed disrespect for all such signs.



W13–1
18″ x 18″

The plate shall be mounted on the same assembly with the standard warning sign, normally below it. With warning signs larger than 36 inches on a side, the 24-inch Advisory Speed plate should be used. In this case the warning sign should be mounted at a height of 6 feet above the level of the roadway, and the Advisory Speed plate should be mounted on the post nearer the roadway, its top level with the bottom corner of the warning sign.

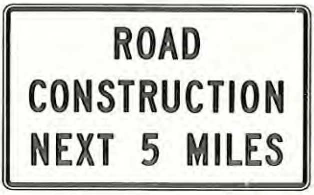
Guide Signs

Section 5B–35 Application of Guide Signs

Guide signs required at construction and maintenance operations include (1) normal directional signs and route markings, to the extent that temporary route changes are necessitated by road closings and detours, and (2) special informational signs relating to the work being done. The signs described in the following sections should be used where applicable.

5B–36 Length of Construction Sign (G20–1)

The Length of Construction guide sign shall be erected at the limits of any major road construction or maintenance job of more than 2 miles in extent, where traffic is maintained through the job.

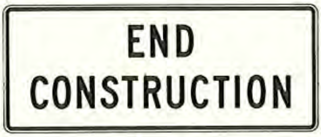


G20–1
60″ x 36″

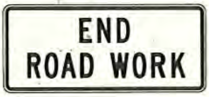
It carries the legend ROAD CONSTRUCTION NEXT (5) MILES. It can be effectively mounted on a wing barricade (sec. 5C–5).

5B–37 End Construction Sign (G20–2)

The END CONSTRUCTION sign shall be erected approximately 500 feet beyond the end of a major construction or maintenance job to indicate the limit of any restrictions or special precautions that have been imposed. Often it will suffice to place this sign on the back of the warning sign set up facing the opposite direction of traffic or on the back of a wing barricade (sec. 5C–5).



G20–2
60" x 24"



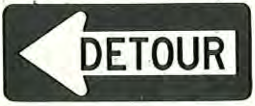
G20–3
42" x 18"

5B–38 End Road Work Sign (G20–3)

At minor maintenance operations marked by Men Working or Road Work Ahead signs, an END ROAD WORK sign should be used in a manner similar to the End Construction sign (sec. 5B–37) at the end of the work zone. Where the limits of the work zone are obvious, such as at a culvert repair job, a sign beyond the site will usually be unnecessary.

5B–39 Detour Arrow Sign (M5–7)

The Detour Arrow sign is used at a point where a detour roadway or route has been established due to the closure of a part of a highway to through traffic. It should normally be mounted just below the Road Closed sign (sec. 5B–8) or the Local Traffic Only sign (sec. 5B–9).



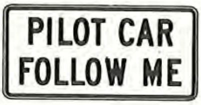
M5–7
48" x 18"

The Detour Arrow sign must be made with the arrow pointing to right or left as required at each location. **Because it may be the only indication of the direction the detour takes, the standard size of this sign for construction and maintenance installations shall be 48 inches by 18 inches.**

Where the detour is of any considerable length, it should be adequately marked with standard temporary route markers and destination signs, as a responsibility of the highway department. Where an unmarked route is detoured, and on short detours in urban areas, the Detour Arrow sign in a 24- by 9-inch size (sec. 1D–24) may be used to indicate the points at which the detour changes direction.

5B–40 Pilot Car Sign (G20–4)

The Pilot Car sign shall be mounted in a conspicuous position on the rear of a vehicle used for guiding controlled one-way traffic through or around a road construction or maintenance project (sec. 5E–10). It carries the legend PILOT CAR—FOLLOW ME. A flagman must be stationed on every approach to a project on which a pilot car is used, to hold traffic as necessary until the pilot car is available to lead.



G20–4
36" x 18"

C—BARRIERS AND CHANNELIZING DEVICES

Section 5C–1 Function

Adequate barriers and channelizing devices, such as barricades, cones, drums, and sandbags, properly used, are essential to the safety of workmen and of the traveling public at most road construction and maintenance jobs. These devices, of themselves, convey no specific message, though a barricade may have signs mounted on it. They are intended to impose an obstacle, real or apparent, in the normal channel of travel, or to mark a limited channel of travel. They must be highly visible in themselves, but they should also be protected by adequate advance warning devices and by suitable lighting devices at night (secs. 5D–1 to 4). The provisions that follow are intended, in general, to apply to relatively high-speed, open highway situations.

Barricades

Section 5C–2 Application of Barricades

Barricades, as the name implies, are generally used to block off a part or all of a roadway, as illustrated in figures 5–5 to 5–9, and 5–11.

Where a road is closed to traffic, Class I barricades (sec. 5C–3)

shall be erected at the points of closure. They may extend completely across a roadway and its shoulders as a fence, but where the road must be open for access of equipment and authorized vehicles, barricades should be provided with gates or movable sections that can be closed when work is not in progress, or with indirect openings that will not invite public entry.

Oftentimes barricades close only a part of a roadway. In this case they must be placed across the entire width of the closed lane or lanes, including any adjacent travelable shoulder. They may be placed at an angle across the roadway, but generally it is preferable to place a barricade at right angles to the direction of approaching traffic. A barricade should never be placed in the line of traffic without advance warning devices. It is desirable to provide a line of cones or torches to guide traffic around a barricade which is in the path of traffic, if it is to be by-passed. To narrow a roadway gradually a series of barricades is often effective, with the first one on the shoulder and the succeeding ones each extending farther into the roadway (sec. 5E–1). A series of closely spaced cones or drums (sec. 5C–7), in line and preceded by a wing barricade (sec. 5C–5), can sometimes serve the same purpose. At horizontal or vertical curves where sight distances are inadequate, barricading should start sufficiently in advance of the curve to be fully visible to approaching traffic (fig. 5–5).

Beyond a barricade closing one or more lanes, it may be necessary to confine the traffic to certain lanes for some distance. Additional transverse barricades may be placed at close intervals in the closed lane or a series of Class II barricades (sec. 5C–3), cones, drums, or sandbags may be set in a longitudinal row along the edge of the closed area.

5C–3 Design of Barricades

The standard barricade shall be of either of two types, Class I or Class II, as here described (fig. 5–3).

A Class I barricade shall consist of three horizontal rails of nominal 8- or 10-inch width spaced vertically at approximately 20 inches, center to center, with the upper edge of the top rail at a height of approximately 5 feet above the roadway level. Barricades may be of variable length as required, and long barricades may be assembled from units of any convenient size. The Class I barricade is the type normally required for major operations, where the barricade must remain in place for extended periods.

A Class II barricade shall consist of a single horizontal rail of nominal 8- or 10-inch width, and length as required, with its

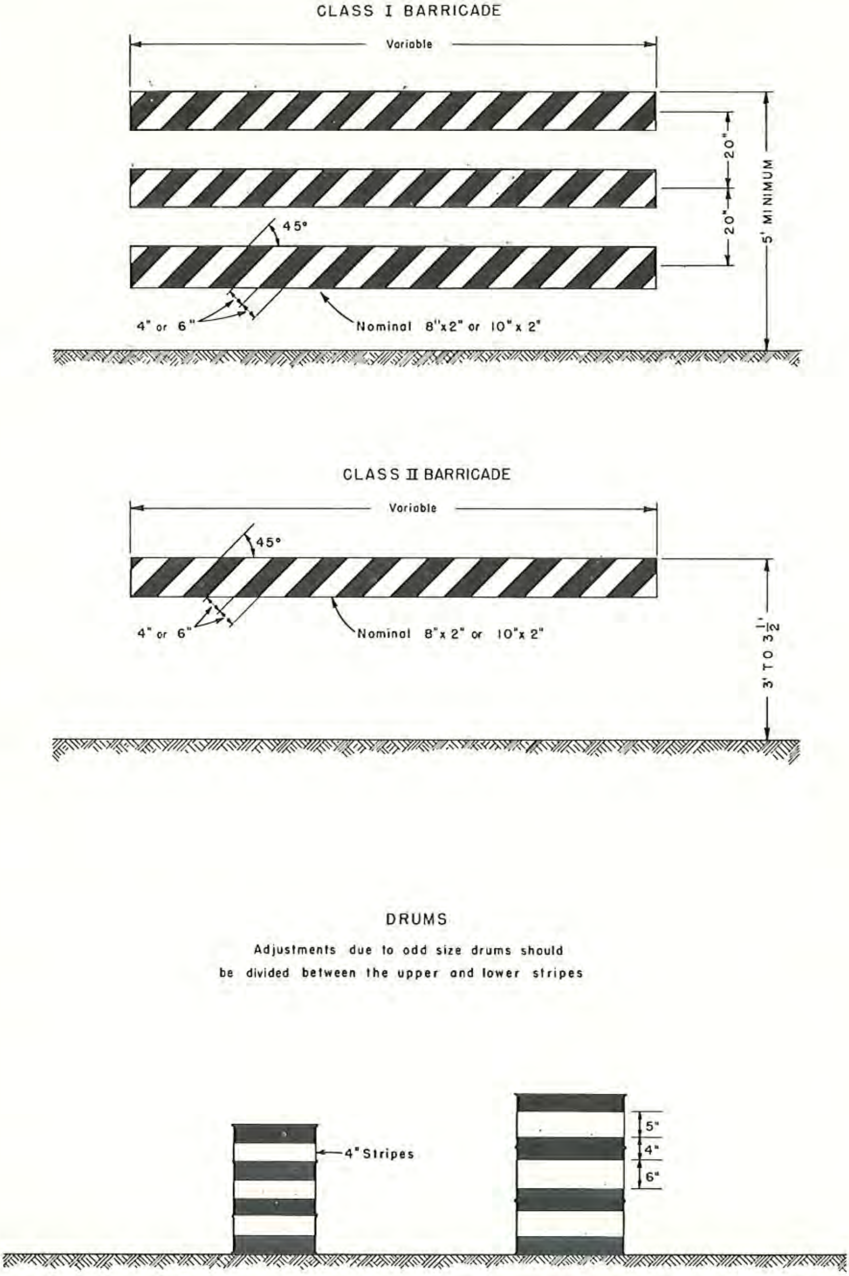

CLASS I BARRICADE
Variable
20"
20"
5' MINIMUM
45°
4" or 6"
Nominal 8"x 2" or 10" x 2"
CLASS II BARRICADE
Variable
45°
4" or 6"
Nominal 8" x 2" or 10" x 2"
3' TO 3½'
DRUMS
Adjustments due to odd size drums should
be divided between the upper and lower stripes
4" Stripes
5"
4"
6"

Figure 5–3. Standard barricade designs and drum markings.

top edge 36 to 42 inches above the roadway. This type is intended for use where the hazard is relatively small as, for example, on city streets, or for the more or less continuous delimiting of a restricted roadway, or for temporary daytime use.

The standard marking for barricades, as hitherto prescribed by this Manual, calls for alternate black and white sloping stripes. Although the effectiveness of this striping has been questioned, the evidence currently available does not appear to justify a recommendation for changing the standard. It is suggested, therefore, that pending further research the present standard be continued, but that the use of unstriped all-white barricades be permitted on an experimental basis. Similarly, the use of yellow in place of white on striped or unstriped barricades is permissible.

Where the striping is employed, each barricade rail shall be marked with alternate black and white (or yellow) stripes of 4- to 6-inch width at an angle of 45 degrees with the vertical, slanting downward toward the side on which traffic is to pass.

The direction of slope of the stripes cannot always follow the rule set forth above, as many barricades must not be passed on either side. Where a barricade extends entirely across a roadway, it is suggested that the stripes slope downward in the direction toward which traffic must turn in detouring. Where both right and left turns are provided for, the stripes should slope downward in both directions from the center.

All barricades used at night shall be effectively reflectorized. For increased emphasis at night lights or flashers may be mounted on barricades. Red flags may be similarly used during daylight hours.

5C–4 Construction of Barricades

Depending on the nature of the requirements, barricades may be fixed or movable. For fixed barricades the horizontal rails are mounted on posts set firmly in the ground. Fixed barricades are justified only for major construction or reconstruction work, particularly where local drivers have shown a propensity for evading movable barricades by shifting them to one side. They may also be necessary on rough ground or sloping shoulders, where a movable barrier will not stay in place. A type of fixed barricade is illustrated in figure 5–4.

Movable barricades are appropriate where the construction or maintenance operations are of short duration, or are progressively shifted along a roadway, or where occasional passage of equipment must be provided for. Various types of construction are suitable, some of which are illustrated in figure 5–4. The design

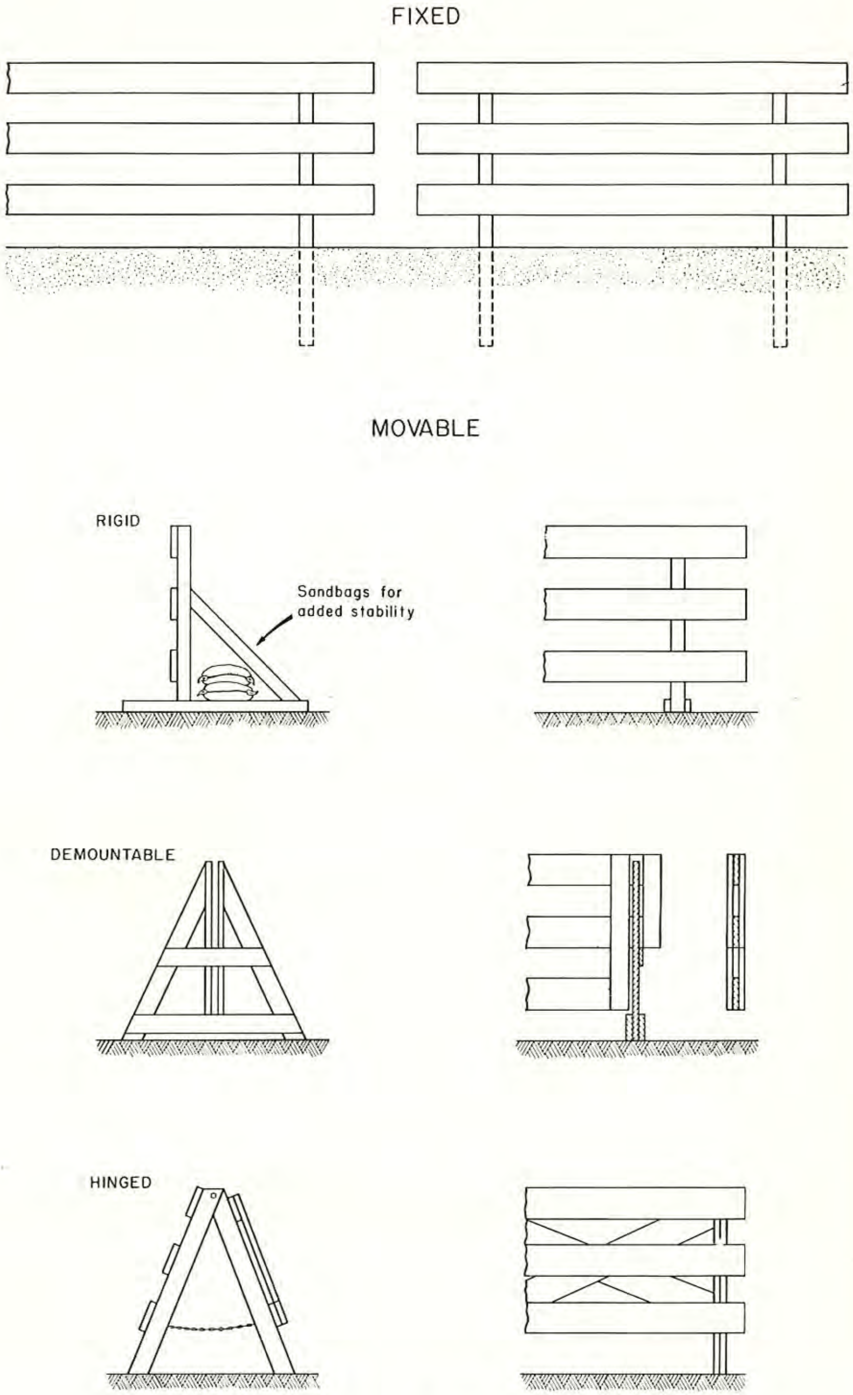

FIXED
MOVABLE
RIGID
Sandbags for added stability
DEMOUNTABLE
HINGED

Figure 5–4. Class I barricade construction—typical examples.

of movable mountings must be such as to resist overturn by ordinary strong winds or by chance contact with vehicles.

Movable Class I barricades are generally of heavy rigid construction with a heavy base. Added resistance to overturning may be provided by sandbags. Where portability is of greater importance, a hinged and folding type is sometimes used.

Movable Class II barricades are commonly of the "horse" type, either rigid, hinged, or demountable. The rail on a horse barricade should be striped on both sides so that by reversing it the stripes will slope in the opposite direction.

Barricades need not, and ordinarily should not, be designed with sufficient strength to stop any vehicles that collide with them.

5C–5 Wing Barricades

In advance of a construction or maintenance area, even where no part of the roadway is actually closed, wing barricades serve a useful purpose in alerting the driver. Wing barricades are Class I barricades erected on the shoulder, on one or both sides of the pavement, to give the sensation of a narrowing or restricted roadway. If used in a series they should start at the outer edge of the shoulder and be brought progressively closer to the pavement. Wing barricades may be used as a mounting for the advance warning or guide signs or for flashers. Examples of wing barricades are shown in figure 5–2.

5C–6 Signs on Barricades

Barricades, particularly those of the fixed type, offer a most advantageous facility for the erection of signs (fig. 5–2). The Road Closed and Detour Arrow signs, and the Large Arrow warning signs, for example, can effectively be mounted above the barricade that closes the roadway. The effectiveness of Construction Approach Warning signs can be enhanced by placing them on wing barricades adjacent to the roadway.

Auxiliary Barrier and Channelizing Devices

Section 5C–7 Cones and Drums

Where traffic volumes, speeds, and visibility are such as not to require the more substantial Class I or II barricades, effective use can be made of cones or drums. Cones and drums should not be regarded as an alternative to rail barricades. Under some circumstances, however, they can properly serve some of the same functions as barricades.

Cones, in particular, are often a useful adjunct to standard barricades. They are especially useful during such temporary activities as pavement marking or tree trimming, where the portability of cones is a great advantage. In series, cones or drums can mark the outer limit of a travelable roadway adjacent to a ditch or an unfinished shoulder. Single drums can mark projecting manholes in a roadway under construction, or small but dangerous breaks in a pavement. Where portability is secondary, drums are preferable to cones in that they provide a heavier and more substantial barricade and encourage drivers to keep at a safe distance.

Particularly on rural highways, cones or drums should never be placed in the roadway without advance warning signs or wing barricades.

Cones are commercially available in various sizes from 18 inches to 30 inches in height, with a broadened base, and are made of rubber or other material to withstand impact without damage to themselves or to striking vehicles. Cones of the larger sizes should be used where speeds are relatively high or wherever else conspicuous guidance is necessary. Cones are usually yellow in color and often have black bases and red peaks. **It is here prescribed that yellow or yellow-orange shall be the predominant color on a cone.** Cones should be kept clean or brightly painted. Because cones can be easily moved or knocked down, they should be used only where there is sufficient supervision to see that they remain in place.

Drums are normally metal drums, of 30- to 50-gallon capacity, set on end. To be consistent with the present standard for obstruction markings, they should be conspicuously painted with at least two horizontal, circumferential white stripes, 4 to 6 inches wide (fig. 5–3). However, as in the case of barricades, solid white or solid yellow, or yellow stripes may be used on an experimental basis. **The white or yellow areas shall be reflectorized on drums used at night.**

5C–8 Sandbags

Where space is limited, sandbags can be an effective compromise between cones and drums, though sandbags are less portable than either. Drivers will not tend to shy away from them as much as from drums, yet they provide a more stable barrier than do cones. They are a very effective channelizing device, performing a function similar to that of curbing. Sandbags should be coated with reflectorized yellow paint, which can be applied in place.

5C–9 Delineators

Delineators, commonly used to indicate the alinement of roadways, have little application in road work areas where the devices described herein are effectively employed to guide and channelize traffic. They can be useful, however, in outlining a temporary roadway that is otherwise poorly defined.

5C–10 Pavement Markings

Where traffic control devices have been installed in accordance with the principles set forth in this Manual, the appropriate signs, arrows, barricades, and channelizers should suffice to move traffic through or around the work area in a safe and orderly fashion.

It may sometimes be necessary to remove existing center and lane lines that lead directly into barricades or work sites. New center lines, lane lines, channelizing lines, and no-passing lines may be desired on the approach to, and throughout the length of, a temporary road by-passing a closed portion of highway. **Such lines shall be reflectorized.** Pavement markings at temporary obstructions, however, are often impractical as they are not easily shifted to meet changing requirements. Where it is physically impossible to paint lines on the temporary road, appropriate delineators, in addition to Large Arrow signs, should be used to define the course of the roadway.

Pavement markings shall be approved by public authority prior to installation.

D—LIGHTING DEVICES

Section 5D–1 Hazard Warning Lighting

At night, when clarity and distance of vision are sharply curtailed, adequate artificial lighting is needed to call attention to and to indicate the actual location of obstructions and hazards. Recognition of reflectorized barricades and channelizing devices will occur only at limited distances and will also depend on the adequacy of the approaching headlamps. Therefore, independent light sources capable of being seen at long distances must be provided. These light sources include torches, lanterns, flashers, and electric lamps.

5D–2 Torches and Lanterns

Torches include all the single-unit, portable, constant-burning, low-intensity types of lights, either battery-powered or open-flame (pot torch) variety. Because they provide little illumination of other objects, and, except for the electric type, are not altogether dependable under adverse conditions, torches should be used for the most part only to supplement other channelizing devices or barricades, and to outline obstructions or hazards. Used in this manner they function both as warnings and delineators in guiding traffic. Several torches may also be used to mark a flagman station. Drums with torches on top of them are an effective channelizing device.

Open-flame torches may be dangerous where pedestrians, and particularly children, can approach them too closely. Under such conditions consideration should be given to the use of electric torches or lighting.

Lanterns include all the enclosed-flame types of lights. Their value in illuminating other objects is negligible. They should be used for the most part only in low-speed urban areas to mark the location and extent of hazards and obstructions at the side of the roadway, and those to which pedestrians are exposed. Only red-globe lanterns should be used.

Torches and lanterns are often more effective if they are above ground level. They should always be placed on a solid support to prevent them from tipping over. Lanterns should be maintained in an upright position to prevent smoking and sooting of the globes.

Torches placed in a row across the path of oncoming traffic should be no more than 8 feet apart and usually not less than 4 feet apart. Torches or lanterns in a longitudinal row should be spaced from 15 to 25 feet apart.

Torches and lanterns should be in place and lighted from sunset to sunrise. Fuel-burning types should be inspected and filled daily.

5D–3 Flashers

Flashers are portable, power-operated, lens-directed, enclosed lights, illuminated by rapid intermittent flashes of short duration. They are alerting devices to be used for advance warning or for the marking of severe or unexpected hazards in or near the roadway. **The color of the light emitted by a flasher shall be yellow.** Flashers are best mounted on barricades in or near the roadway at a height of 4 feet or more. The use of flashers in series is not recommended. An array of random flashers can be disconcerting and may tend to obscure rather than delineate the traveled way. Instead, steadily burning lights should be used for delineation.

Data are not available on which to base more detailed specifications and standards of application. It is recommended, however, that the rate of flash be regular with from 70 to 120 flashes per minute and that the "on" time be at least 25 percent of the cycle.

During the hours of darkness, the flash should be bright enough to be conspicuously visible at all distances up to 800 feet from the unit under normal atmospheric conditions. Where a unit with directional faces is used, this specification should be met at angles up to 10 degrees to the sides and up to 5 degrees above and below the photometric axis.

5D–4 Electric Lights

Where commercial power or a portable electric generator is available, electric lights may be used both for illumination and hazard marking.

Electric lights can be used for floodlighting dangerous conditions and illuminating signs, barricades, and flagman stations. **Lights used for illuminating signs or barricades shall be sufficient in size and number to provide effective illumination and legibility under normal atmospheric conditions.** Precautions must be taken when placing lights to insure the prevention of glare.

A series of low-wattage lamps may be used to mark obstructions and hazards. Lamps used for this purpose should be yellow. A line of yellow lights can be effectively used on a longitudinal fence-type barricade to delineate the traveled way. **When illuminated, hazard-marking lights shall burn steadily and shall not be flashed.**

E—CONTROL OF TRAFFIC THROUGH WORK AREAS

Lane Closures

Section 5E–1 Taper Rates

Under relatively normal conditions of speeds and volumes, and where adequate advance warning of a lane obstruction has been provided, a taper rate of 1:20 should be sufficient to permit traffic to shift safely from one lane to another. Where speeds or volumes are high this rate should be substantially decreased, to about 1:40; expressway-type facilities may require even longer tapers. Where traffic is stopped or considerably slowed in advance of the transition, as by flagmen, and where the lane change does not involve a merging of traffic streams, the taper may be very short, just long enough for traffic to turn comfortably into the appropriate lane (fig. 5–5).

Cones, drums, or barricades shall be used to funnel traffic into the appropriate lane. Normally, barricades should be spaced at

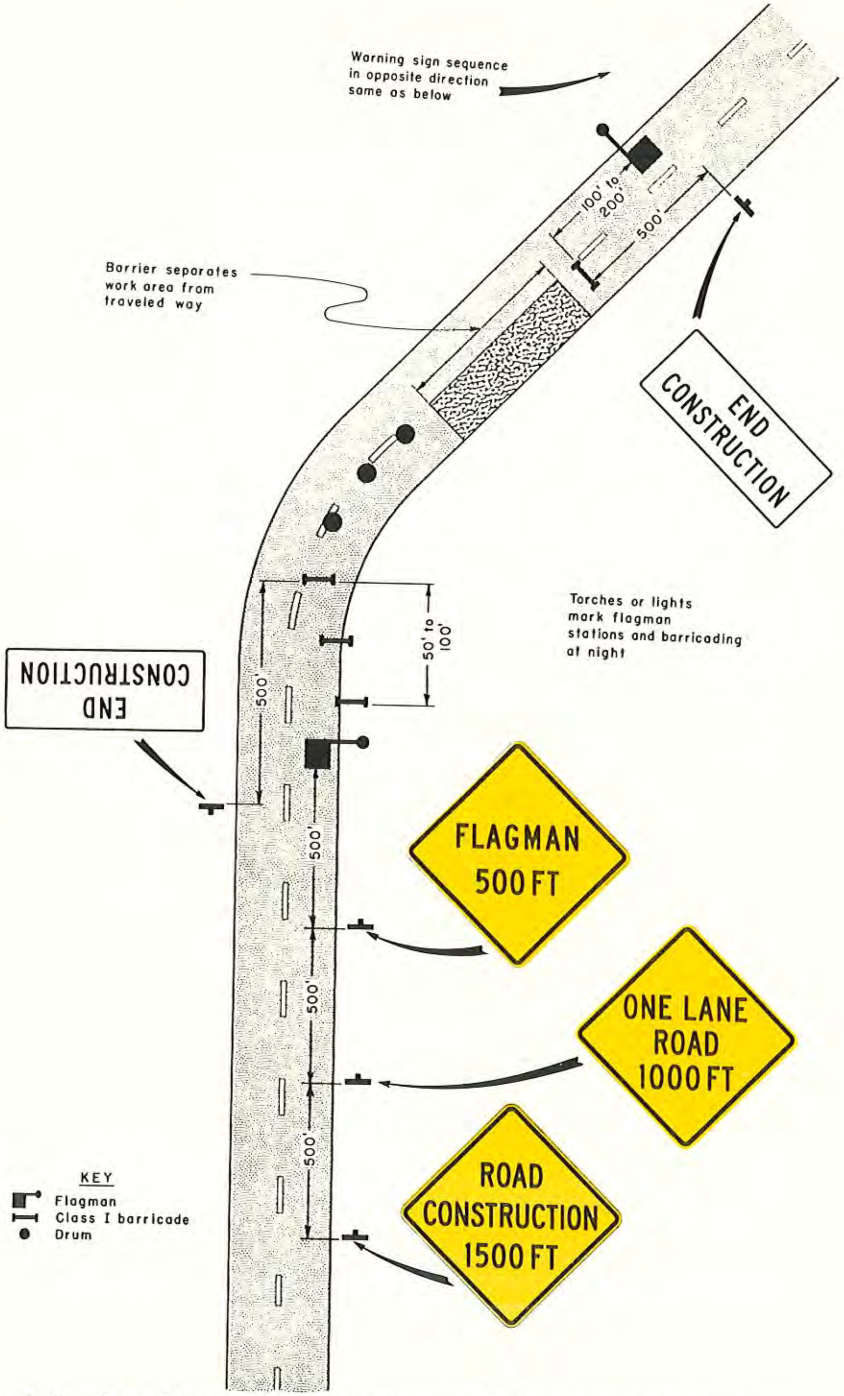

Warning sign sequence in opposite direction same as below
100' to 200'
500'
Barrier separates work area from traveled way
END CONSTRUCTION
Torches or lights mark flagman stations and barricading at night
50' to 100'
END CONSTRUCTION
500'
500'
FLAGMAN 500 FT
500'
ONE LANE ROAD 1000 FT
500'
ROAD CONSTRUCTION 1500 FT
KEY
Flagman
Class I barricade
Drum

***Figure 5–5.** Typical applications of traffic control devices on 2-lane highway where one lane is closed. Barricading is extended to a point where it is visible to approaching traffic.*

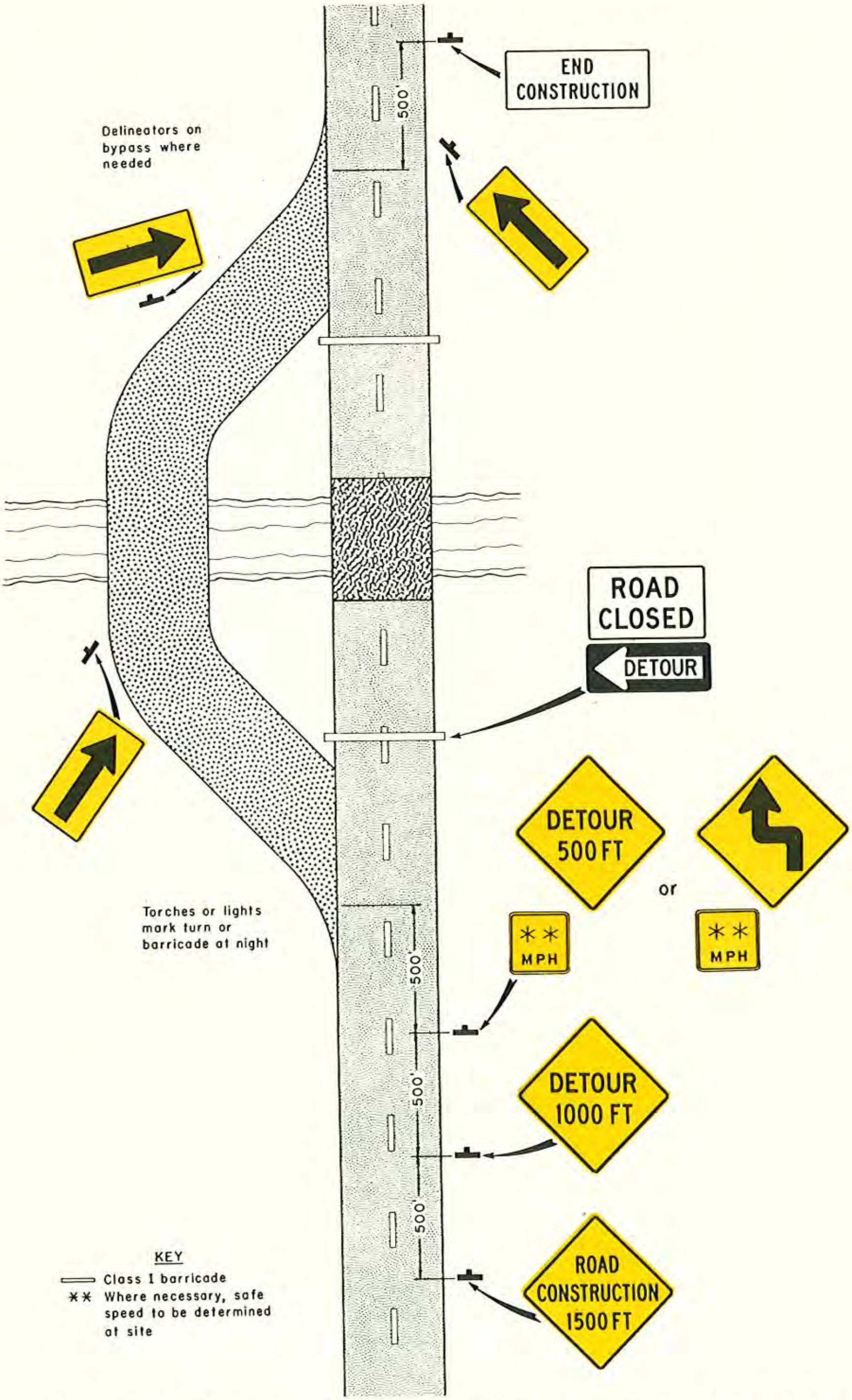

END CONSTRUCTION
500'
Delineators on bypass where needed
ROAD CLOSED
DETOUR
DETOUR 500 FT
or
** MPH
** MPH
Torches or lights mark turn or barricade at night
500'
500'
DETOUR 1000 FT
500'
ROAD CONSTRUCTION 1500 FT
KEY
Class I barricade
** Where necessary, safe speed to be determined at site

Figure 5–6. Typical applications of traffic control devices on 2-lane highway where the entire roadway is closed and a bypass detour is provided (signs shown for one direction of travel only).

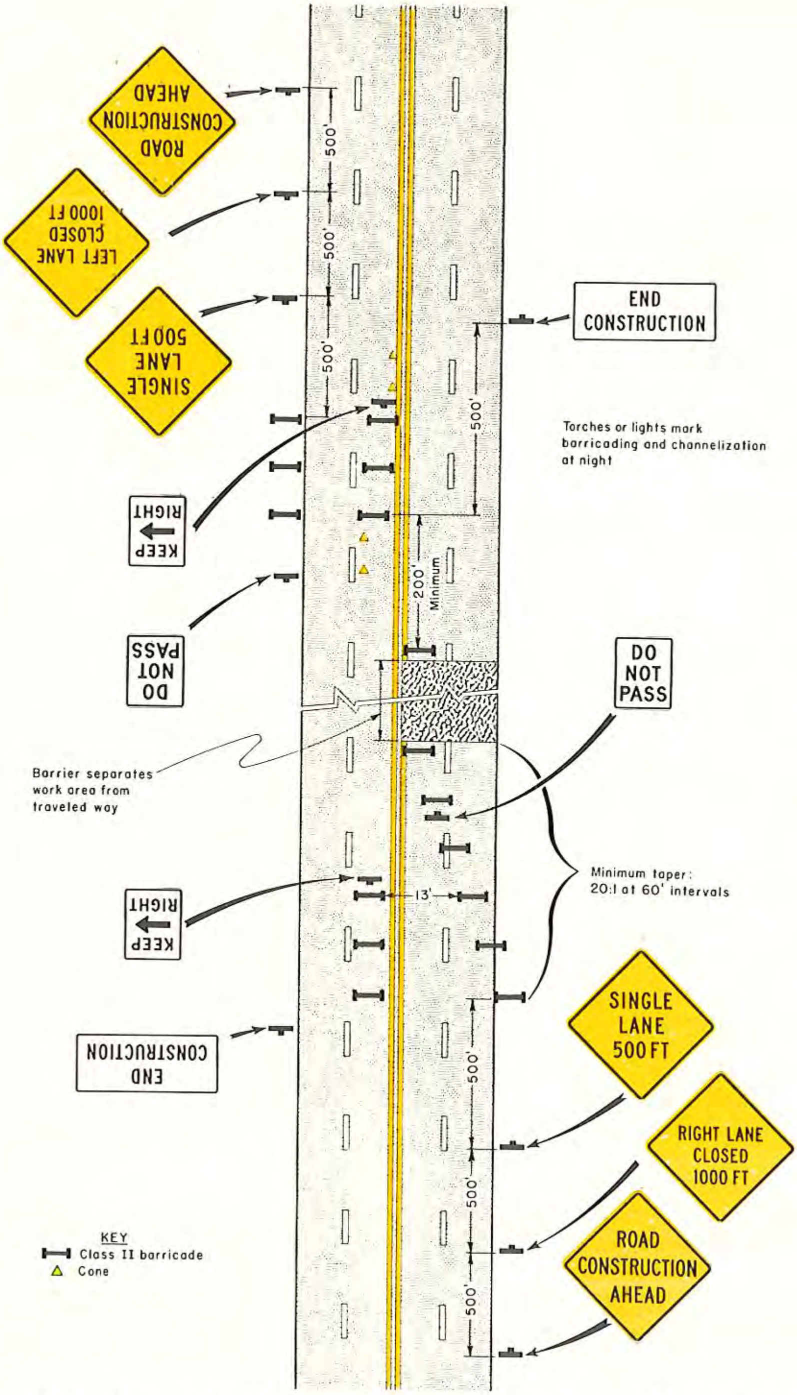

ROAD CONSTRUCTION AHEAD
LEFT LANE CLOSED 1000 FT
SINGLE LANE 500 FT
500'
500'
500'
END CONSTRUCTION
500'
Torches or lights mark barricading and channelization at night
KEEP RIGHT
DO NOT PASS
200' Minimum
DO NOT PASS
Barrier separates work area from traveled way
Minimum taper: 20:1 at 60' intervals
13'
KEEP RIGHT
END CONSTRUCTION
SINGLE LANE 500 FT
RIGHT LANE CLOSED 1000 FT
ROAD CONSTRUCTION AHEAD
500'
500'
500'
KEY
Class II barricade
△ Cone

Figure 5–7. Typical applications of traffic control devices on 4-lane undivided highway where half the roadway is closed.

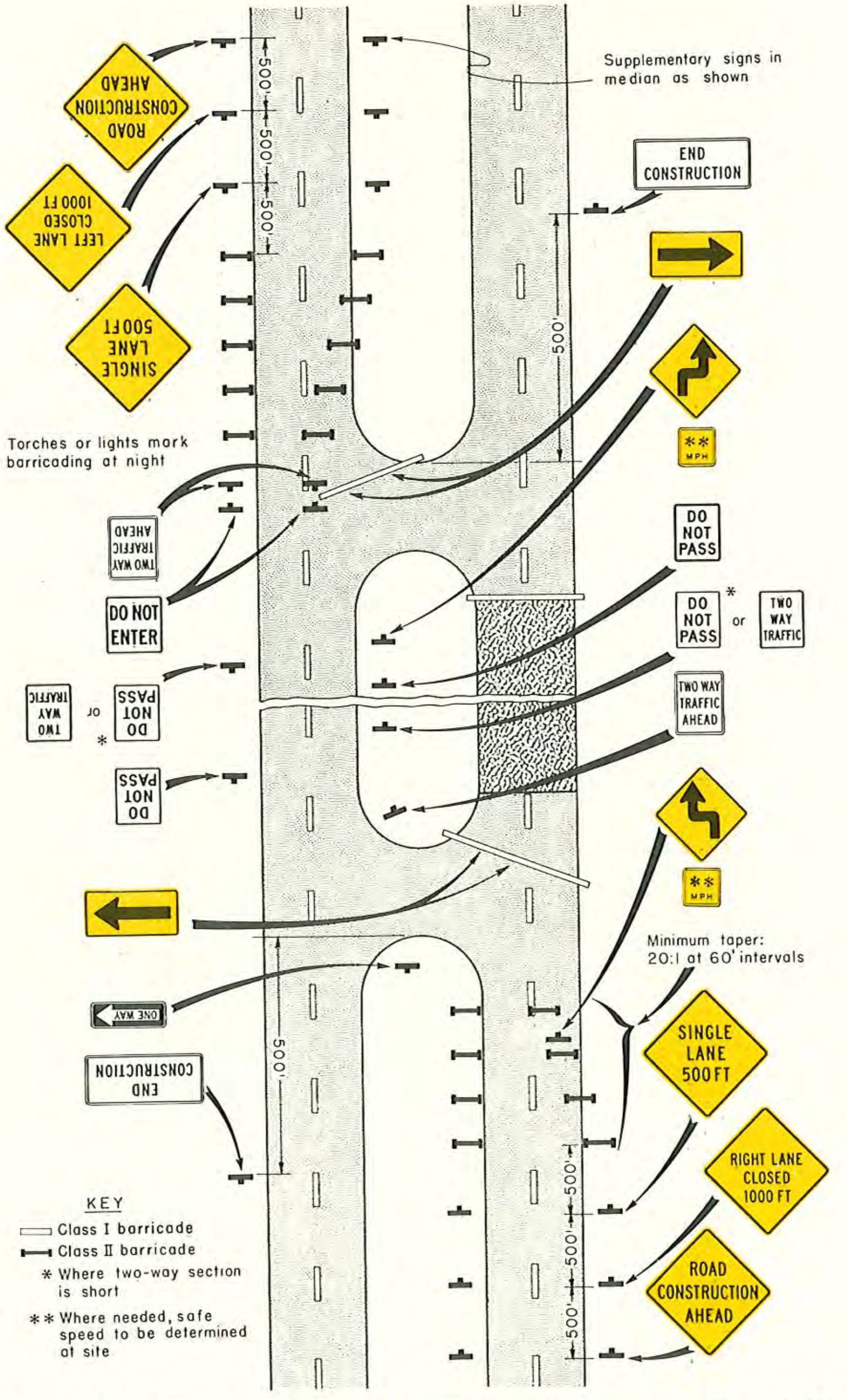

Supplementary signs in median as shown
500'
500'
500'
ROAD CONSTRUCTION AHEAD
LEFT LANE CLOSED 1000 FT
SINGLE LANE 500 FT
END CONSTRUCTION
500'
**
MPH
Torches or lights mark barricading at night
TWO WAY TRAFFIC AHEAD
DO NOT ENTER
DO NOT PASS
DO NOT PASS
*
or
TWO WAY TRAFFIC
TWO WAY TRAFFIC AHEAD
DO NOT PASS
or
TWO WAY TRAFFIC
*
DO NOT PASS
**
MPH
Minimum taper: 20:1 at 60' intervals
ONE WAY
500'
END CONSTRUCTION
SINGLE LANE 500 FT
RIGHT LANE CLOSED 1000 FT
ROAD CONSTRUCTION AHEAD
500'
500'
500'
KEY
Class I barricade
Class II barricade
* Where two-way section is short
** Where needed, safe speed to be determined at site

***Figure 5–8.** Typical applications of traffic control devices on 4-lane divided highway where one roadway is closed.*

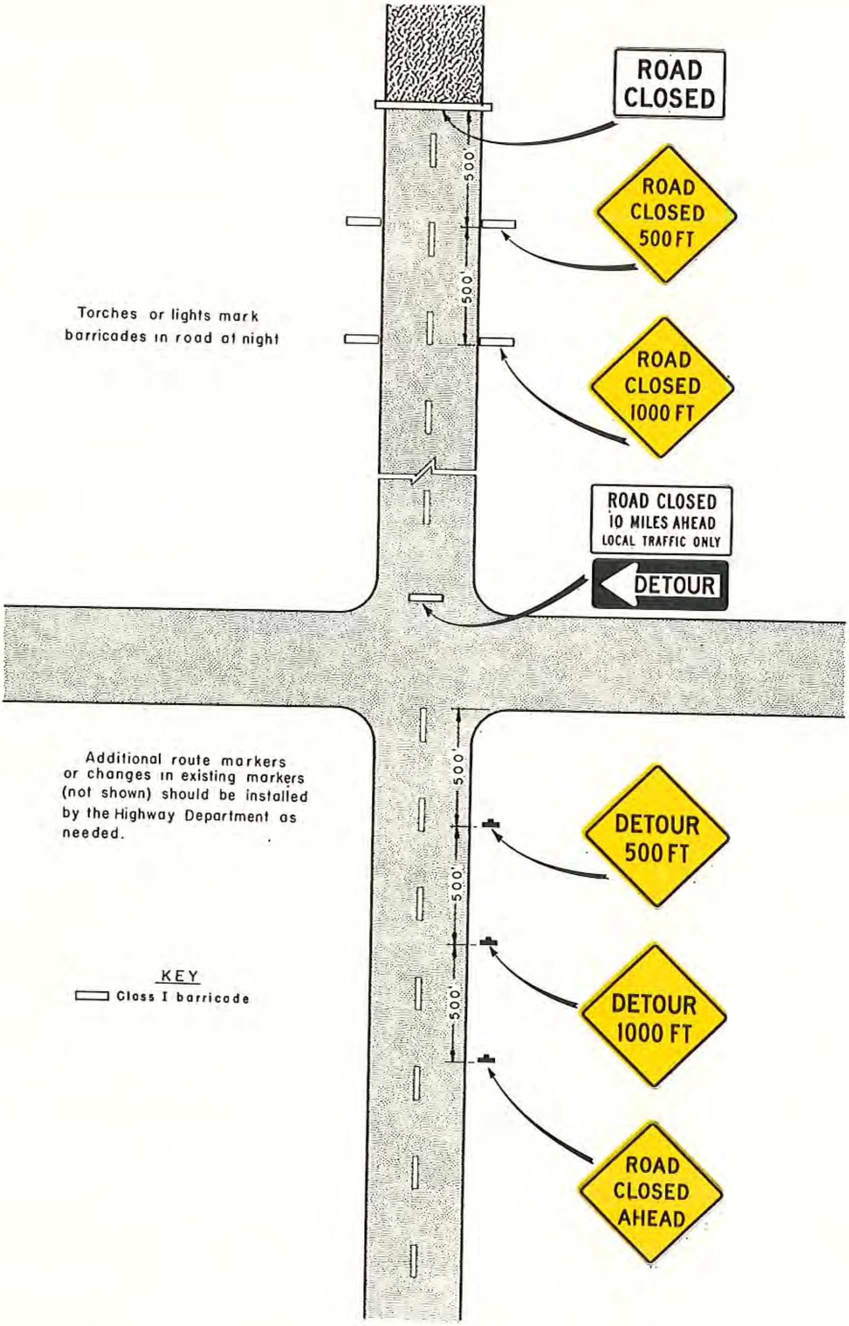

ROAD CLOSED
ROAD CLOSED 500 FT
ROAD CLOSED 1000 FT
500'
500'
Torches or lights mark barricades in road at night
ROAD CLOSED 10 MILES AHEAD LOCAL TRAFFIC ONLY
DETOUR
Additional route markers or changes in existing markers (not shown) should be installed by the Highway Department as needed.
500'
500'
500'
DETOUR 500 FT
DETOUR 1000 FT
ROAD CLOSED AHEAD
KEY
Class I barricade

Figure 5–9. Typical applications of traffic control devices where a road is closed beyond a detour point.

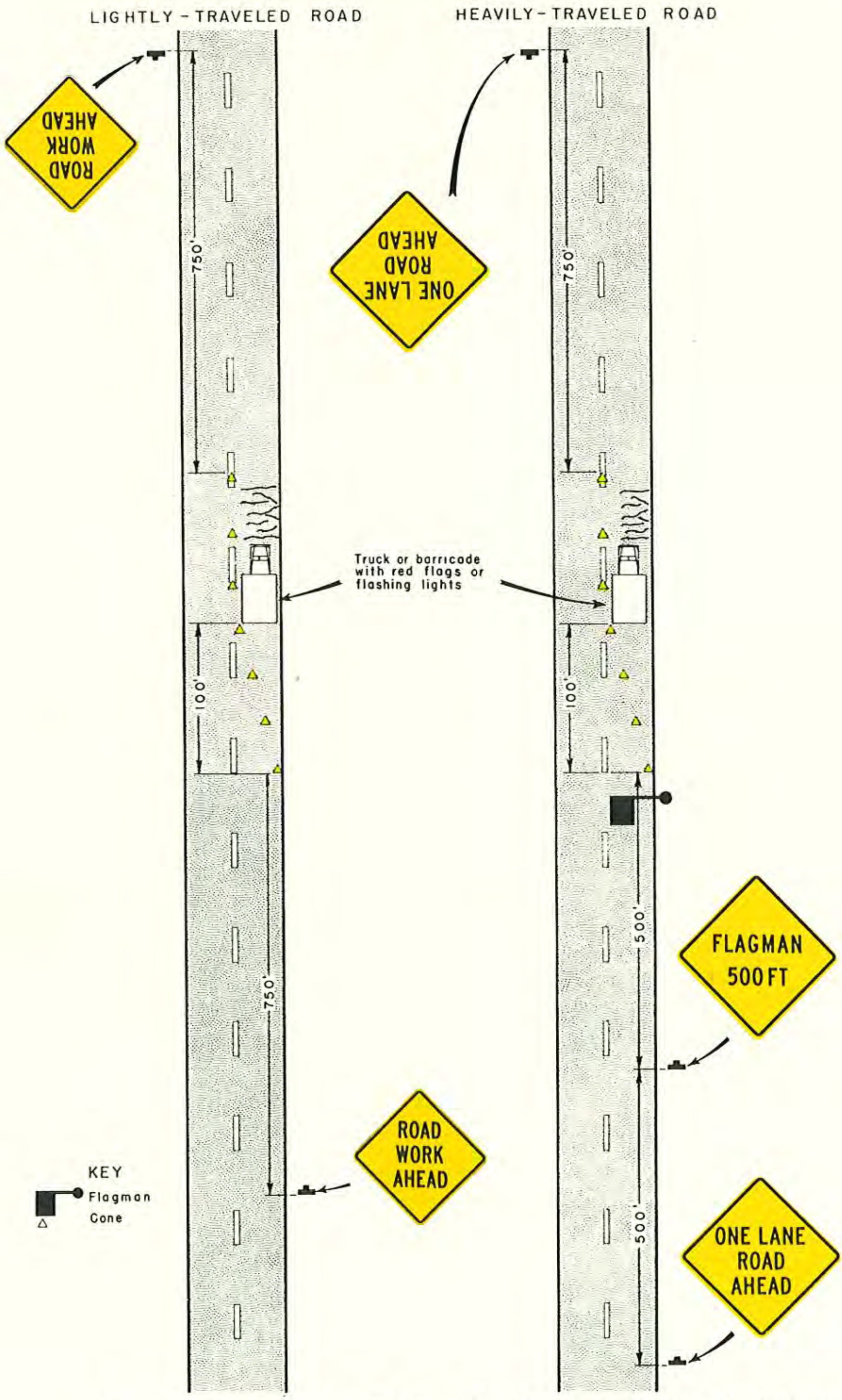

LIGHTLY-TRAVELED ROAD
HEAVILY-TRAVELED ROAD
ROAD WORK AHEAD
ONE LANE ROAD AHEAD
750'
750'
Truck or barricade with red flags or flashing lights
100'
100'
500'
FLAGMAN 500 FT
750'
ROAD WORK AHEAD
500'
ONE LANE ROAD AHEAD
KEY
Flagman
Cone

Figure 5–10. *Typical applications of traffic control devices at minor maintenance operations of short duration.*

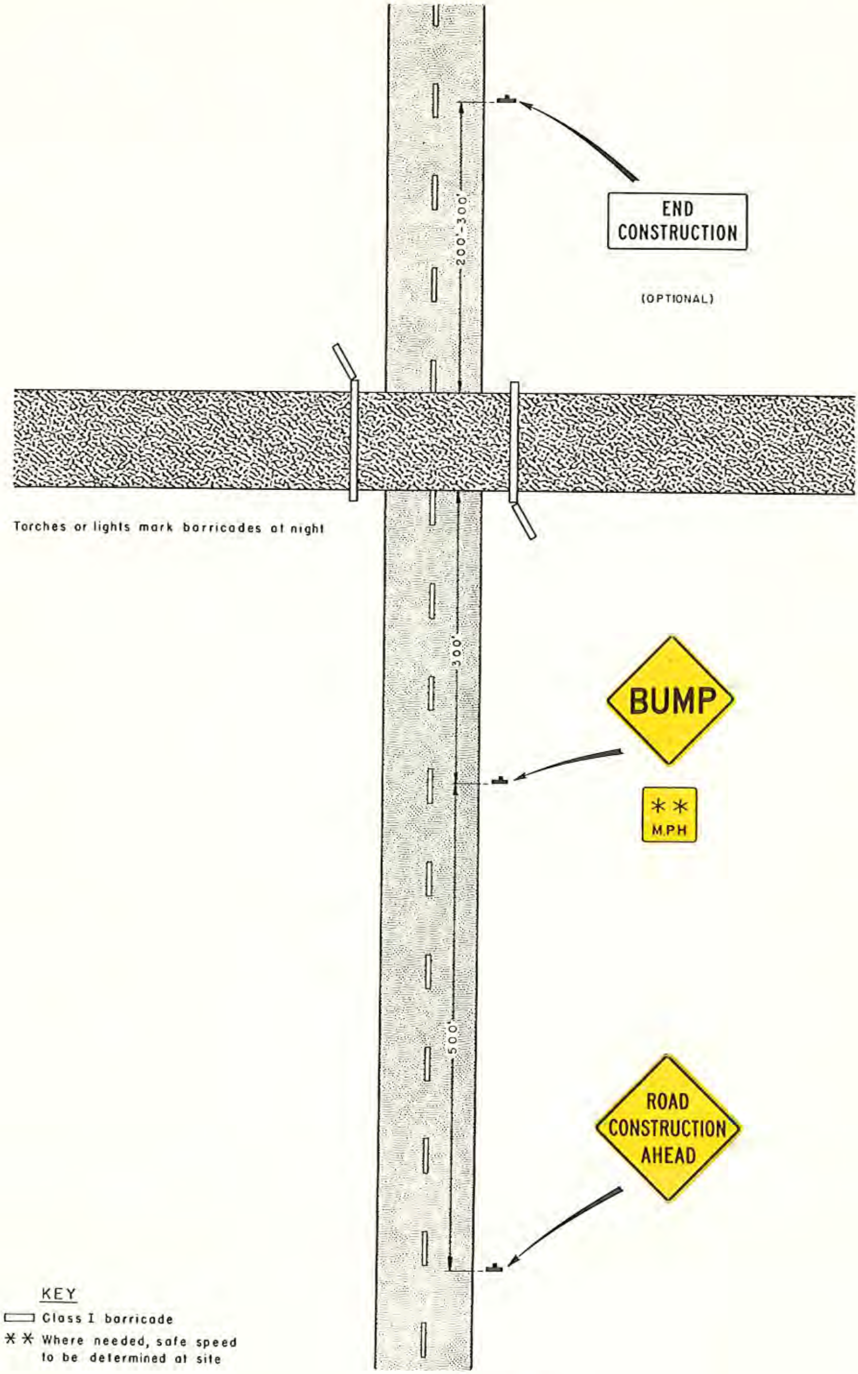

END
CONSTRUCTION
(OPTIONAL)
200'-300'
Torches or lights mark barricades at night
300'
BUMP
* *
M.P.H
500'
ROAD
CONSTRUCTION
AHEAD
KEY
Class I barricade
* * Where needed, safe speed to be determined at site

Figure 5–11. *Typical applications of traffic control devices on a road crossing a construction job.*

approximately 60-foot intervals; the smaller cones or drums should be more closely spaced.

5E–2 Multiple Closings

Where two or more lanes of a multilane highway are to be closed, traffic should not be forced to vacate more than a single lane at any one point, i.e., the points of closure of each lane should be separated in distance to prevent the compounding of merging maneuvers. This distance should be on the order of 500 feet. Additional Construction Approach Warning or other appropriate signs should be placed between the points of closure. A continuous taper across two or more lanes is permissible, however, where traffic already moving in a single line is required to shift lanes (fig. 5–7).

Flagging Traffic

Section 5E–3 Hand Signaling Devices

A number of hand signaling devices, such as red flags, STOP and GO signs, and red lights are used in controlling traffic through work areas. The red flag is the most common device used during the daylight hours. The sign paddle bearing the clear regulatory messages STOP, GO, or SLOW is also used. Use of the paddle, however, requires the flagman to divert some of his attention from the traffic he is controlling to the manipulation of the paddle. Furthermore, the paddle cannot be used where a single flagman must stop traffic in both directions simultaneously.

Flags used for signaling purposes shall be a minimum of 18 by 18 inches in size, made of a good grade of bright red material securely fastened to a staff approximately 3 feet in length. The free edge should be weighted to insure that the flag will hang vertically, even in heavy winds.

Sign paddles shall be at least 15 inches wide, with bold lettering at least 5 inches in height. A rigidly fixed handle should be provided. This combination sign may be fabricated from sheet metal or other light semirigid material. **The background of the STOP face shall be red with white letters, and the background of the GO face shall be dark green with white letters. If SLOW is used instead of STOP the background shall be highway yellow with black letters.**

To increase the visibility of the flagman, the use of a yellow cap and a yellow vest worn over the outer clothing is recommended. For nighttime conditions the use of similar outside garments or belting, preferably reflectorized, is recommended. In addition, flagman stations should be adequately illuminated to attract attention.

5E–4 Choice of Flagmen

Since flagmen make the greatest number of public contacts of all construction personnel and are responsible for human safety, it is important that well qualified personnel be selected. A flagman should possess the following qualifications:

1. Average intelligence.
2. Good physical condition, including sight and hearing.
3. Mental alertness.
4. Courteous but firm manner.
5. Neat appearance.
6. Pleasing personality.
7. Sense of responsibility for safety of public and crew.

5E–5 Flagman Stations

Flagman stations should be located far enough from the work site so that vehicles will have sufficient distance to slow down before entering the project but not so far that vehicles will tend to speed up into the work site.

Normally the flagman will stand either on the shoulder adjacent to the lane of traffic he is controlling or in the barricaded lane. At a "spot" obstruction he may have to stand on the shoulder opposite the barricaded section. Under no circumstances should he stand in the traffic lane. In rural areas he should be clearly visible to the traffic he is controlling for a distance of 500 feet. For this reason he must stand alone, never permitting a group of workmen to congregate around him. Flagman stations must be adequately protected and preceded by proper advance warning signs.

In urban areas flagmen will usually be needed only to provide for the passage of equipment. The flagman, therefore, is able to choose an appropriate time to stop traffic safely. **Where for any length of time the flagman must continuously control traffic, the provisions pertaining to flagman stations in rural locations shall apply.**

5E–6 Flagging Procedures

The following methods of signaling shall be used:

1. To stop traffic, the flagman shall face traffic and extend the flag horizontally across the traffic lane in a stationary position so that the full area of the flag is visible hanging below the staff. For greater emphasis, the free arm may be raised with the palm toward approaching traffic.

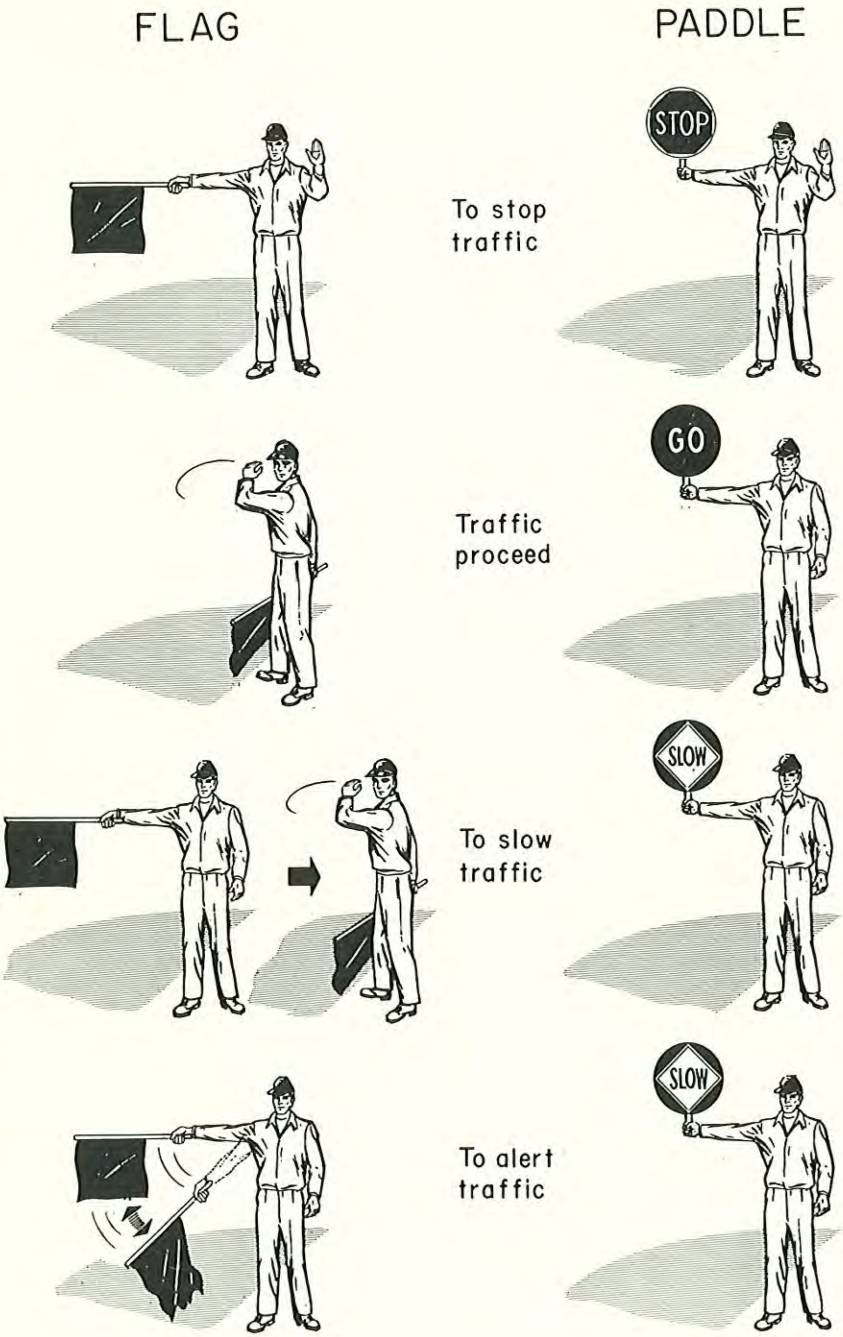

FLAG
PADDLE
STOP
To stop traffic
GO
Traffic proceed
SLOW
To slow traffic
SLOW
To alert traffic

***Figure 5–12.* Use of hand signalling devices by flagman.**

2. When it is safe for traffic to proceed, the flagman shall stand parallel to the traffic movement, and, with flag and arm lowered from view of the driver, motion traffic ahead with his free arm. Red flags shall not be used to signal traffic to proceed.

3. To slow traffic, the flagman shall display the stop signal and give the signal to proceed before the vehicle comes to a stop.

4. Where it is desired to alert traffic by means of flagging, but where a substantial reduction in speed is not necessary, the flagman shall face traffic and wave the flag in a sweeping motion of the arm across the front of the body without raising the arm above a horizontal position.

If a sign paddle is used, it shall be held in a stationary position with the arm extended horizontally away from the body. Figure 5–12 illustrates the use of the red flag and sign paddle.

Red lanterns or lights should be used to flag traffic at night. To stop traffic the light should be waved back and forth across the path of the approaching vehicle. The signal to proceed should be given verbally or by a hand motion. Adequately reflectorized sign paddles or flags may be used at night provided that the reflectorization is of a type that will retain its brilliance when wet. **Daytime flagging procedure shall be followed whenever such paddles or flags are used at night.**

Whenever practicable the flagman should advise the motorist of the reason for the delay and the approximate period that traffic will be halted. Flagmen and operators of construction machinery or trucks should be made to understand that every reasonable effort must be made to allow the driving public the right-of-way and prevent excessive delays.

One-Way Traffic Control

Section 5E–7 Coordinating Movements

Where traffic in both directions must for a limited distance use a single lane, some provision must be made for alternate one-way movement to pass traffic through the constricted section. At a "spot" obstruction, such as an isolated pavement patch, the movement may be self-regulating. However, where the one-lane section is of any length there must be some means of coordinating movements at each end so that vehicles are not simultaneously moving in opposite directions in the section and so that delays are not excessive at either end. Control points at each end of the route must be chosen so as to permit easy passing of opposing lines of vehicles.

Alternate one-way traffic control may be effected by the following means:

Flagman control.
Flag-carrying or official car.
Pilot car.
Traffic signals.

5E–8 Flagman Control

Where the one-lane section is short enough so that the approaches to both ends are intervisible, traffic may be controlled by means of a flagman at each end of the section. One of the two should be designated as the chief flagman for purposes of coordinating movement. They should be able to communicate with each other verbally or by means of signals. These signals should not be such as to be mistaken for flagging signals.

Where the ends of the one-lane section are not intervisible, the flagmen may maintain contact by means of field telephones. So that a flagman may know when to allow traffic to proceed into the section, the last vehicle from the opposite direction can be identified by description or license number.

5E–9 Flag-Carrying or Official Car

Flag carrying is effective when the route is well defined and nonhazardous. It should be employed only when the one-way traffic is confined to a relatively short stretch of road, not more than 1 mile in length.

The driver of the last vehicle proceeding into the one-lane section is given a red flag (or other token) and instructed to deliver it to the flagman at the other end. The opposite flagman, upon receipt of the flag, then knows that it is safe to allow traffic to move in the other direction. The flag being carried should always be clean and dry.

A variation of this method is the use of an "official" car which always follows the last vehicle proceeding through the section. The use of an official car eliminates the delays associated with dispatching and delivering the flag and also eliminates the possibility of loss of the flag.

5E–10 Pilot Car

The use of a pilot car for traffic control can be most effective where the route is particularly hazardous, or so involved or frequently altered as to preclude adequate signing. The pilot car is used to guide a train of vehicles through the job or detour. Its operation must be coordinated with flagging operations or other controls at each end of the one-lane section. Sufficient turnaround room should be provided at these points. Provision must also be made for identification of the last vehicle in the column.

The vehicle selected for pilot-car duty should be lightweight and easy to handle and should have the name of the contractor or contracting authority prominently displayed. **The Pilot Car sign (sec. 5B–40) shall be mounted on the rear of the vehicle.**

Two or more pilot cars can be used to guide two-way traffic through a particularly complex or hazardous detour.

5E–11 Traffic Signals

Short one-way detours, such as bridge construction by-passes, can sometimes be controlled by means of traffic signals. Use of traffic signals at longer one-way zones may result in longer delays than will be accepted by motorists.

If used, the traffic signals shall be installed at each approach to the one-lane section, and drivers shall be apprised of their presence by means of the Signal Ahead sign (sec. 1C–16) preceded by appropriate Construction Approach Warning signs.

The signals should be timed so that a short green interval will allow traffic to enter the one-way zone while the opposing traffic is halted. Upon expiration of the green time the signals at both ends must show red for a sufficient time for traffic to clear the zone at the minimum normal speed expected through the zone. The signal should then show green for the opposite movement.

It may be found desirable to use a traffic-actuated signal or manual control to compensate for unbalanced flow. Whatever signal scheme is used, however, a simultaneous red phase in both directions is inescapable.

Traffic signals shall consist of standard three-lens units and shall be installed and timed only with the approval of the responsible highway authorities. They shall be erected to the right of traffic approaching the work site, or overhead, at a point where vehicles can be stopped without encroaching on the opposite lane. The bottom of the housing of the signal face shall be at a height of not less than 8 nor more than 15 feet above the roadway, or not less than 15 nor more than 17 feet where vehicles must pass under the signal housing.

F—URBAN APPLICATIONS

Section 5F–1 Urban Characteristics

The general principles outlined in the previous sections of this Manual are applicable to both rural and urban areas. Discussion of their application, however, has emphasized rural conditions.

The differences between rural and urban situations warrant some separate treatment of urban traffic-control requirements, though basically it is possible only to point out certain ways in which the standards already set forth can be adapted to peculiarly urban problems.

Urban traffic conditions are characterized by relatively low speeds, high traffic volumes, limited maneuvering space, frequent turns and cross movements, and a significant pedestrian movement. Traffic obstructions particularly in the form of parked vehicles, are common. Construction and maintenance operations are more numerous and varied, including such diverse activities as pavement cuts for utility work, pavement patching and surfacing, pavement marking renewal, and encroachments by adjacent building construction.

There is already ample conflict inherent in urban traffic movement, and further conflict due to construction or maintenance operations should be kept to a minimum. On arterial streets such work should, if possible, be restricted to off-peak hours. Some cities have resorted to extensive night work in order to minimize interference with traffic.

The amount of street space taken up by construction and maintenance work should be no more than is absolutely necessary, though this does not justify any failure to use such signs, warning devices, and channelization as may be required in the roadway for public protection and guidance.

5F–2 Signs

Changes in operation may be necessary to maintain traffic movement through an area where a major street is closed or partly obstructed. Additional regulatory signs, such as One Way signs (sec. 1B–28), Do Not Enter signs (sec. 1B–26), and No Parking signs (sec. 1B–31), will be needed to control traffic under such conditions. Because of the unfamiliar and possibly unusual conditions, larger sizes may be warranted than the standard sizes normally specified for these signs in urban use. Where a street must be closed to through traffic but where access to adjacent property can be maintained, a special sign with the suggested message LOCAL TRAFFIC ONLY should be used in connection with any detour signs or barricades that are present at the points of closure.

Because of the lower speeds associated with urban traffic conditions as compared with rural, fewer advance warning signs are required. The messages of most of the warning signs described previously are applicable, with the substitution of "street" for "road" if desired. Under some circumstances warning signs may not be necessary, but other devices capable of being clearly seen and recognized at a safe distance are essential.

Warning signs of standard size should generally be used. Construction Approach Warning signs (secs. 5B–19 to 5B–25), however, may be 36 inches by 36 inches in size. On minor streets where speeds and volumes are low, other warning signs may be 24 inches by 24 inches in size. Larger signs may be needed than are called for by speed criteria alone due to high traffic volumes, wide streets, and competition from advertising displays and distracting backgrounds.

Warning signs should be placed at distances of 150 to 250 feet in advance of the condition to which they are calling attention, the actual distance being determined by such factors as speeds, volumes, degree of hazard, and sight distance.

Standards for warning signs on urban expressways should be essentially the same as for rural highways, as previously described.

Detour routings will not often be needed except for numbered routes and major arterial routes. Short detours may be marked with the standard Detour Arrow sign (sec. 5B–39). Because of the circulatory characteristics of urban traffic, a variety of information and guide signs may be needed on the approaches to the work site. Traffic desiring to use an arterial street which is closed or on which travel is restricted may have to be informed of such restrictions and of alternate routings far in advance.

Regulatory, guide, and information signs can usually be erected at the curbs, although it may sometimes be more advantageous to place them on barricades, pedestals, or other temporary supports in the roadway. Warning signs are usually placed in the roadway, where they will have maximum visibility. They should be of such a height as to be visible above preceding vehicles.

5F–3 Barrier, Warning, and Channelizing Devices

All of the devices described in sections 5C–1 to 5C–10 are applicable to urban situations. Because of space limitations, cones may find greater use than barricades.

Class I barricades (sec. 5C–3) should be used where a street is closed to all traffic except authorized vehicles or to all but local traffic.

Class II barricades (sec. 5C–3) should be used to separate work areas, excavations, equipment and materials, and spoil from traffic areas and to separate pedestrian walkways from vehicular traffic areas. Where space permits, they may be used for channelization.

Where space is limited, or where they are needed for short durations, cones or drums (sec. 5C–7) may be used for channelization or to mark the safe approach to obstructions adjacent to traffic areas.

During the day, red flags may be used to call attention to signs (so long as they do not interfere with a clear view of the sign face), barricades, or equipment. A tripod device may be used to display flags or, at night, flashers or electric torches, high enough to be visible over preceding vehicles.

Although most city streets are lighted at night, special attention must be called to the existence of obstructions and hazards, due to construction or maintenance work, during hours of darkness. The devices described in sections 5D–1 to 5D–4 are appropriate for this purpose.

Part VI

SIGNING FOR CIVIL DEFENSE

Section 6A–1 Civil Emergencies

The Office of Civil and Defense Mobilization has developed plans for the control of highway traffic under emergency conditions such as could result from accidental disaster or enemy attack. Particularly these plans are concerned with the possibilities of nuclear warfare.

For the prompt evacuation of threatened areas, the program contemplates the advance designation and marking of "Evacuation Routes." In the event of disaster there will be a closing of highways that cannot be used, a controlled operation of certain designated highways, the establishing of regulation posts for the expediting of essential traffic, and the provision of emergency centers for civilian aid.

To guide and control highway traffic in an emergency, special highway signs will be needed. The signs here specified have been approved by the Office of Civil and Defense Mobilization and are here prescribed as standard for use when and where applicable in the civil defense program.

These emergency signs will not permanently displace any of the standard signs that are normally applicable, and as conditions permit they should be replaced or augmented by standard signs.

6A–2 Design of Civil Defense Signs

For economy in stockpiling and in emergency fabrication all the special civil defense signs, with the exception of the Evacuation Route Marker, are designed for a single size of plate measuring 24 by 30 inches, and have a black legend and border on a white background. The background should be reflectorized.

In an emergency these signs may be needed in large numbers. Except for the Evacuation Route Markers, however, which may remain in service indefinitely, they are for essentially temporary use. Consideration should accordingly be given to their fabrication from any light and economical material that can serve through the emergency period.

Any of these signs may be accompanied by a standard triangular marker approved by the Office of Civil and Defense Mobilization for marking areas contaminated by biological and chemical warfare agents and radioactive fallout.

6A–3 Evacuation Route Marker (CD–1)

If advance warning of enemy attack can be given it is expected that the residents of urban targets will be evacuated into safer areas. To facilitate this movement "Evacuation Routes" will be selected in cooperation with local highway authorities and marked with a distinctive marker.

The Evacuation Route Marker shall be a circular sign, having a minimum outside diameter of 18 inches, carrying a directional arrow and the legend EVACUATION ROUTE. The standard Civil Defense Symbol, CD inscribed in a triangle within a ring, shall appear near the bottom of the sign, with a diameter of 3½ inches. The legend, arrow, symbol, and border shall be in white on a blue background. At least the arrow and border shall be reflectorized. The arrow designs shall include a straight vertical arrow pointing upward, a straight horizontal arrow pointing to left or right, and a bent arrow pointing to left or right for advance warning of a turn. The arrow may be a separate unit attached to the face of the sign.

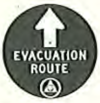
The Evacuation Route Marker, with the appropriate arrow, shall be erected 150 to 300 feet in advance of, and at, any turn in an evacuation route, and elsewhere for straight-ahead confirmation where needed. In urban areas it shall be mounted at the right of the roadway, not less than 7 feet above the top of the curb, and at least 1 foot back from the face of the curb. In rural areas it shall be not less than 5 feet above the crown of the roadway and 6 to 10 feet to the right of the roadway edge.

Evacuation Route Markers shall not be placed where they will conflict with normal signs. Where conflict in placement would occur between the Evacuation Route Marker and a standard regulatory sign, the latter shall take precedence. In case of conflict with a standard informational sign the civil defense sign may take precedence.

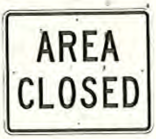
Placement of Evacuation Route Markers should be made under the supervision of the officials having jurisdiction over the placement of normal traffic signs, but coordination and agreement between contiguous political entities will be necessary to assure continuity of routes.

6A–4 Area Closed Sign (CD–2)

The AREA CLOSED sign shall be used to close a roadway entering an area from which all traffic is excluded because of dangerous radiological or biological contamination. It shall be erected on the shoulder as near as practicable to the right-hand edge of the roadway, or preferably on a portable mounting or barricade partly or wholly in the roadway. For best visibility, particularly at night, its height should not normally exceed 4 feet to the bottom of the sign. Unless adequate advance warning signs are used, it should not be so placed as to create a complete and unavoidable blockade. Where feasible, the sign should be located at an intersection that provides a detour route.



CD–1
18″ diameter (blue)

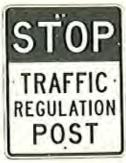


CD–2
30″ x 24″

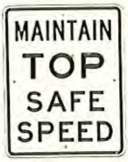
6A–5 Traffic Regulation Post Sign (CD–3)

The STOP—TRAFFIC REGULATION POST sign shall be used to designate a point where an official post has been set up to impose such controls as are necessary to limit congestion, expedite emergency traffic, exclude unauthorized vehicles, or protect the public. It shall be erected in the same manner as the Area Closed sign (sec. 6A–4) at the point where traffic must stop to be checked.

For emphasis the word STOP shall be in white letters on a black panel at the top of the sign, the remainder of the legend being black on a white background. The word STOP, like the white background, should be reflectorized.



CD–3
24″ x 30″



CD–4
24″ x 30″

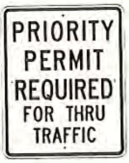
6A–6 Emergency Speed Sign (CD–4)

The MAINTAIN TOP SAFE SPEED sign may be used on highways where radiological contamination is such as to limit the permissible exposure time for occupants of vehicles passing through the area. Since any speed zoning would be impractical under such emergency conditions, no minimum speed limit can be prescribed by the sign in numerical terms. Where traffic is supervised by a traffic regulation post, official instructions will usually be given verbally, and the sign will serve as an occasional reminder of the urgent need for all reasonable speed.

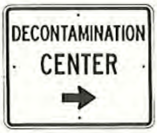
The sign should be erected at random intervals as needed, in the same manner as other standard speed signs. **In rural areas it shall be mounted on the right-hand side of the road with its lower edge not less than 5 feet above the crown of the roadway, 6 to 10 feet from the roadway edge. In urban areas the height shall be not less than 7 feet, and the nearest edge of the sign shall be not less than 1 foot back from the face of the curb.** Where an existing Speed Limit sign is in a suitable location, the Top Safe Speed sign may conveniently be mounted directly over the face of the older sign, which it supersedes.

6A–7 Priority Permit Sign (CD–5)

The PRIORITY PERMIT REQUIRED FOR THRU TRAFFIC sign is to be used at an intersection, at the entrance to a route on which a traffic regulation post is located. Its intent is to notify drivers of the presence of the post so that those who do not have priority permits issued by civil defense authorities can detour on another route, or turn back, without making a needless trip and without adding to the screening load at the post. Local traffic, without permits, may proceed as far as the regulation post. **The sign shall be erected in a manner similar to that of the Emergency Speed Sign (sec. 6A–6).**



CD–5
24" x 30"



CD–6
30" x 24"

6A–8 Emergency Aid Centers Signs (CD–6, etc.)

In the event of emergency, civil defense authorities will establish various centers for civilian relief, communication, medical service, and similar purposes. To guide the public to such centers a series of directional signs will be needed. **These signs shall carry the designation of the center and an arrow indicating the direction to the center. They shall be erected as needed, at intersections and elsewhere, on the right-hand side of the roadway, at a height in urban areas of at least 7 feet, and not less than 1 foot back from the face of the curb, and in rural areas at a height of 5 feet, 6 to 10 feet from the roadway edge.**

These signs shall carry one of the following legends, as appropriate, or others designating similar emergency facilities:

DECONTAMINATION CENTER
REGISTRATION CENTER
WELFARE CENTER
MEDICAL CENTER

Appendix A—DEFINITIONS

General Definitions

1. *Crosswalk*—(a) That part of a roadway at an intersection included within the connections of the lateral lines of the sidewalks on opposite sides of the highway measured from the curbs or, in the absence of curbs, from the edges of the traversable roadway; (b) Any portion of a roadway at an intersection or elsewhere distinctly indicated for pedestrian crossing by lines or other markings on the surface.

2. *Curb*—A vertical or sloping member generally along and defining the edge of a roadway.

3. *Curb line*—The boundary between a roadway and a sidewalk, usually marked by a curb.

4. *District, Business*—The territory contiguous to and including a highway when within any 600 feet along such highway there are buildings in use for business or industrial purposes, including but not limited to hotels, banks, or office buildings, railroad stations, and public buildings which occupy at least 300 feet of frontage on one side or 300 feet collectively on both sides of the highway.

5. *District, Residence*—The territory contiguous to and including a highway not comprising a business district when the property on such highway for a distance of 300 feet or more is in the main improved with residences or residences and buildings in use for business.

6. *District, Rural*—Any territory not included in a business or residence district as defined herein, whether or not within the boundaries of a municipality.

7. *District, Urban*—The territory contiguous to and including any street which is built up with structures devoted to business, industry, or dwelling houses situated at intervals of less than 100 feet for a distance of a quarter of a mile or more.

8. *Expressway*—A divided arterial highway for through traffic with full or partial control of access and generally with grade separations at intersections.

9. *Freeway*—A divided arterial highway with full control of access and with no crossings at grade.

10. *Gore*—The area immediately beyond the bifurcation of two roadways, bounded by the edges of those roadways.

11. *Highway (or Street)*—The entire width between the boundary lines of every way publicly maintained when any part thereof is open to the use of the public for purposes of vehicular travel.

12. *Highway, Arterial*—A general term denoting a highway primarily for through traffic, usually on a continuous route.

13. *Highway, Controlled-Access*—Every highway, street, or roadway in respect to which owners or occupants of abutting lands and other persons have no legal right of access to or from the same except at such points only and in such manner as may be determined by the public authority having jurisdiction over such highway, street, or roadway.

14. *Highway, Divided*—A highway with separate roadways for traffic in opposite directions.

15. *Highway, Major*—The roadway approach or approaches at an intersection normally carrying the major volume of vehicular traffic.

16. *Highway, Minor*—The roadway approach or approaches at an intersection normally carrying the minor volume of vehicular traffic.

17. *Highway, Through*—A highway on which preference is given to the through movement of traffic by the utilization of Stop signs and/or other traffic-control devices on intersecting highways.

18. *Intersection*—The area embraced within the prolongation or connection of the lateral curb lines, or, if none, then the lateral boundary lines of the roadways, of two highways which join one another at, or approximately at, right angles; or the area within which vehicles traveling upon different highways joining at any other angle may come in conflict.

19. *Median*—The portion of a divided highway separating the traveled ways for traffic in opposite directions.

20. *Official Traffic Control Devices*—All signs, signals, markings, and devices placed or erected by authority of a public body or official having jurisdiction, for the purpose of regulating, warning, or guiding traffic.

21. *Pavement*—That part of a roadway having a constructed surface for the facilitation of vehicular traffic.

22. *Pedestrian*—Any person afoot.

23. *Ramp*—An inclined section of way over which traffic passes for the primary purpose of ascending or descending so as to make connections with other ways. Also, an interconnecting roadway of a traffic interchange, or any connection between highway facilities of different levels, on which vehicles may enter or leave a designated highway.

24. *Right-of-Way*—The privilege of the immediate use of the roadway.

25. *Roadway*—That portion of a highway improved, designed, or ordinarily used for vehicular travel, exclusive of the berm or shoulder. In the event a highway includes two or more separate roadways, the term "roadway," as used herein, refers to any such roadway separately but not to all such roadways collectively.

26. *Shoulder*—The portion of the roadway contiguous with the traveled way for accommodation of stopped vehicles, for emergency use, and for lateral support of base and surface courses.

27. *Sidewalk*—That portion of a street between the curb line, or the lateral line of a roadway, and the adjacent property lines, intended for the use of pedestrians.

28. *Street*—(See highway).

29. *Traffic*—Pedestrians, ridden or herded animals, vehicles, streetcars, and other conveyances either singly or together while using any highway for purposes of travel.

30. *Traffic Lane*—A strip of roadway intended to accommodate the forward movement of a single line of vehicles.

31. *Transit Vehicle*—A vehicle designed for carrying more than 10 passengers and used for transportation of persons for compensation.

32. *Vehicle*—Every device in, upon, or by which any person or property is or may be transported or drawn upon a highway, except devices moved by human power or used exclusively upon stationary rails or tracks.

Definitions Relating to Signs

1. *Guide Sign*—A sign used to direct traffic along a route or toward a destination or to give information concerning places or points of interest.

2. *Lane-Use Sign*—A sign indicating regulations governing use of specific lanes.

3. *Legend*—Any message on a sign, whether expressed in words or symbols.

4. *Public Parking Area (or Facility)*—A parking facility available for use by the general public, with or without payment of a fee.

5. *Regulatory Sign*—A sign used to indicate regulations governing use of the highway.

6. *Traffic Sign*—A device mounted on a fixed or portable support whereby a specific message is conveyed by means of words or symbols, officially erected for the purpose of regulating, warnings, or guiding traffic.

7. *Warning Sign*—A sign used to indicate actual or potential hazards to highway users.

Definitions Relating to Markings

1. *Barrier Line*—A line which, when placed parallel to a center or lane line, or to another barrier line, indicates that all traffic must keep to the right thereof.

2. *Center Line*—A line indicating the division of the roadway between traffic moving in opposite directions.

3. *Channelizing Line*—A line which directs traffic and indicates that traffic should not cross but may proceed on either side.

4. *Delineator*—A light-reflecting device mounted at the side of the roadway, in series with others, to indicate the alinement of the roadway.

5. *Edge Line*—A line which indicates the edge of the roadway.

6. *Lane Line*—A line separating two lanes for traffic moving in the same direction.

7. *Stop Line (or Limit Line)*—A line which indicates where vehicles should stop when directed by a traffic officer or traffic control device.

8. *Traffic Markings*—All lines, patterns, words, colors, or other devices, except signs, set into the surface of, applied upon, or attached to the pavement or curbing or to objects within or adjacent to the roadway, officially placed for the purpose of regulating, warning, or guiding traffic.

Definitions Relating to Signals

Signals

1. *Highway Traffic Signal*—Any power-operated traffic-control device, except a sign or a flasher, by which traffic is warned or is directed to take some specific action.

2. *Traffic Control Signal*—Any device whether manually, electrically, or mechanically operated by which traffic is alternately directed to stop and permitted to proceed.

3. *Pretimed Signal*—A type of traffic control signal which directs traffic to stop and permits it to proceed in accordance with predetermined time schedules.

4. *Traffic-Actuated Signal*—A type of traffic control signal in which the intervals are varied in accordance with the demands of traffic as registered by the actuation of detectors.

   a. *Semi-traffic-actuated signal*—A type of traffic-actuated signal in which means are provided for traffic actuation on one or more but not all approaches to the intersection.

   b. *Full traffic-actuated signal*—A type of traffic-actuated signal in which means are provided for traffic actuation on all approaches to the intersection.

c. *Traffic-Adjusted Signal*—A type of traffic control signal in which characteristics of signal display at local controllers in an area or for an artery are continuously varied in accordance with the receipt of traffic-flow information supplied to a computing master control by sampling detectors located at typical flow points in the area.

5. *Flashing Beacon*—A section of a standard traffic signal head, or a similar type of device, having a yellow or red lens in each face, which is illuminated by rapid intermittent flashes.

6. *Pedestrian Signal*—A traffic control signal which is erected for the exclusive purpose of directing pedestrian traffic at signalized locations.

7. *Lane-Direction-Control Signal*—A traffic control signal which is erected to control the direction of vehicular traffic movement in an individual lane.

8. *Train-Approach Signal*—A signal which indicates to highway traffic the approach and passage of railroad trains at a railroad-highway grade crossing.

Signal Systems

1. *Signal System*—Two or more signal installations operating in coordination.

2. *Simultaneous System*—A signal system in which all signals along a given street always give the same indication at essentially the same time.

3. *Alternate System*—A signal system in which alternate signals or groups of signals give opposite indications to a given street at the same time.

4. *Limited Progressive System*—A signal system in which the various signal faces controlling a given street give Go indications in accordance with a time schedule to permit (as nearly as possible) continuous operation of groups of vehicles along the street at a planned rate of speed, which may vary in different parts of the system.

5. *Flexible Progressive System*—A signal system in which the intervals at any signalized intersection may be independently adjusted to the traffic requirements to give the maximum efficiency.

6. *Through Band*—The time in seconds elapsed between the passing of the first and the last possible vehicle in a group of vehicles moving in accordance with the designed speed of a progressive signal system.

7. *Offset*—The number of seconds or percent of the time cycle that the green indication appears at a given traffic control signal after a certain instant used as a time reference base.

8. *Out-of-Step*—That condition of a traffic control signal instal-

lation belonging to a signal system when its operation does not possess the intended relationship to the system.

9. *Recoordination*—Restoration of the intended interrelationship of operation of signals in a signal system.

10. *Remote Cycle Change*—A mechanism applied to the timer of the master controller to make possible, by means of manual operation or by means of an automatic time switch, a change in the time cycle in operation at all local controllers interconnected within a signal system.

11. *Shutdown Feature*—A relay or other device installed in a controller which, when energized from a remote point or by an automatic time switch, discontinues normal traffic control signal operation and turns the signal indications off.

12. *Flashing Feature*—A relay or other device installed in a controller which, when energized from a remote point or by an automatic clock switch, discontinues normal signal operation and causes the flashing of any predetermined combination of signal lights.

Signal Operation

1. *Major Street*—The roadway approach or approaches at an intersection normally carrying the major volume of vehicular traffic.

2. *Minor Street*—The roadway approach or approaches at an intersection normally carrying the minor volume of vehicular traffic.

3. *Signal Indication*—The illumination of a traffic signal lens or equivalent device or a combination of several lenses or equivalent devices at the same time.

4. *Time Cycle*—The time period required for one complete sequence of signal indications.

5. *Interval*—Any one of the several divisions of the time cycle during which signal indications do not change.

6. *Interval Sequence*—A predetermined consecutive order of appearance of signal indications during successive intervals within a time cycle.

7. *Traffic Phase (traffic movement)*—A part of the time cycle allocated to any traffic movement receiving the right-of-way or to any combination of traffic movements receiving the right-of-way simultaneously during one or more intervals.

8. *Vehicular Phase (vehicular movement)*—A traffic phase allocated to vehicular traffic.

9. *Pedestrian Phase (pedestrian movement)*—A traffic phase allocated to pedestrian traffic.

   a. *Combined Pedestrian-Vehicle Phase.*—A traffic phase wherein pedestrians are directed to move on certain crosswalks parallel to the through vehicular movement and wherein vehicles are permitted to turn across the said cross walks.

b. *Semi-Exclusive Pedestrian-Vehicle Phase*—A traffic phase wherein pedestrians are directed to move on certain crosswalks with parallel or other vehicular movements, but vehicles are not permitted to turn across the said crosswalks during the pedestrian movement.

c. *Leading Pedestrian Phase*—Signal phasing wherein an exclusive pedestrian phase, in advance of the minor-street vehicular green phase, is provided for pedestrians crossing the main street only.

d. *Exclusive Pedestrian Phase*—A traffic phase wherein pedestrians are directed to move on any crosswalks or cross the intersection diagonally during an exclusive phase while all vehicles are stopped.

10. *Clearance Interval (generally yellow)*—The time of display of the signal indication following the green interval.

a. *Pedestrian Clearance Interval*—The time of display of the DONT WALK indication following the WALK interval, before opposing vehicles receive a green indication.

11. *Carry-Over*—The effect which a passing platoon (closely spaced group of vehicles) exerts on the controller for the benefit of prompt assignment of the right-of-way for the next following platoon on that traffic phase.

12. *Initial Portion*—The first part of the green interval which is timed out or separately controlled by a traffic-actuated controller before the extendible portion of the interval takes effect.

13. *Extendible Portion*—The part of the green interval following the initial portion.

14. *Unit Extension*—The minimum time during the extendible portion for which the right-of-way must remain on any traffic phase following an actuation on that phase, but subject to the extension limit.

15. *Extension Limit*—The maximum time for which actuations on any traffic phase may retain the right-of-way after actuation on another traffic phase.

16. *Minimum Period*—The shortest period of time that a green interval may be displayed during any traffic phase.

Controllers

1. *Beacon Flasher*—A complete electrical mechanism for controlling the operation of a flashing beacon, including all necessary auxiliary apparatus.

2. *Controller*—A complete electrical mechanism for controlling

the operation of traffic control signals, including the timer and all necessary auxiliary apparatus mounted in a cabinet.

a. *Automatic Controller*—A self-operating controller for operating traffic control signals automatically.

b. *Manual Controller*—A controller for operating traffic control signals by hand.

c. *Pretimed Controller*—An automatic controller for supervising the operation of traffic control signals in accordance with a predetermined, fixed time cycle and divisions thereof.

d. *Synchronous Motor Controller*—An automatic controller operated by a synchronous motor which will maintain a constant speed governed by the frequency of the power supply circuit.

e. *Master Controller*—An automatic controller for supervising a system of secondary controllers, maintaining definite time interrelationship, or accomplishing other supervisory functions.

f. *Traffic-Adjusted Master Controller*—A type of master controller designed to make continuous and automatic selection of cycle lengths, offsets, or other system operating features based on traffic flow information supplied to it from vehicle detectors located within the signal system.

g. *Secondary Controller*—An automatic controller for operating the traffic control signals at an intersection under the supervision of a master controller.

h. *Local Controller*—A controller for operating traffic control signals at an intersection (or two or three proximate intersections) which may be isolated or included in a signal system.

i. *Electronic Controller*—An automatic controller using electronic timing circuits.

j. *Traffic-Actuated Controller*—An automatic controller for supervising the operation of traffic control signals in accordance with the varying demands of traffic as registered with the controller by detectors or push buttons.

3. *Manual Switch*—An auxiliary device for manual operation of an automatic controller.

4. *Timer*—An automatic timing unit in a controller including all dials, circuit contacts, motors, gears, camshaft, etc.

5. *Timing (or Interval) Dial*—A calibrated dial or similar mechanism on an automatic timer equipped with adjusting devices by means of which it is possible to divide the time cycle into the required number of intervals and set up the offset and interlock.

6. *Reset*—An adjustment mechanism applied to an automatic

controller providing for the setting up of the timing arrangement of the start of the green traffic control signal indication.

7. *Automatic Reset*—A reset by means of which the offset or beginning of the green indication is checked automatically, and adjusted if necessary once each time cycle.

8. *Remote Flashing Relay*—A relay installed in a local controller which, when energized from a remote point, causes normal signal operation to be discontinued and specified signal lights to be operated in a flashing manner.

Detectors

1. *Traffic Detector (general definition)*—A device by which vehicles, streetcars, trolley buses, or pedestrians are enabled to register their presence with a traffic-actuated controller.

2. *Pressure-Sensitive Vehicle Detector*—A detector installed in the roadway capable of being actuated by the pressure of a vehicle passing over its surface.

3. *Magnetic Vehicle Detector*—A detector installed in or near the roadway, capable of being actuated by the magnetic or electrical disturbance caused by the passage of a vehicle.

   a. *Compensated Magnetic Vehicle Detector*—Any magnetic detector which is so designed and constructed as not to be affected by changing electromagnetic influences other than those resulting from the passage of a vehicle. When properly equipped, a compensated magnetic detector has substantial directional characteristics.

   b. *Noncompensated Magnetic Detector*—Any magnetic detector other than a compensated magnetic detector.

4. *Sound-Sensitive Vehicle Detector*—A detector installed in the roadway capable of being operated by sound waves generated by the passage of a vehicle over the surface of the detector.

5. *Light-Sensitive Vehicle Detector*—A detector consisting of a light source and photoelectric cell or cells, capable of being operated by the passage of a vehicle interrupting the beam or beams of light. When properly equipped, directional characteristics are present.

6. *Radar Vehicle Detector*—A detector installed over the roadway capable of being actuated by the passage of a vehicle through its field of emitted microwave energy.

7. *Nondirectional Detector*—A detector capable of being actuated by vehicles proceeding in either direction.

8. *Directional Detector*—A detector capable of being actuated only by vehicles proceeding in one direction.

9. *Pedestrian Detector*—A detector, usually of the push-button type, installed near the roadway capable of being operated by hand.

10. *Sampling Detector*—Any suitable type of vehicle detector used to obtain traffic-flow information for a traffic-adjusted master controller.

11. *Detector Amplifier*—Any device such as a relay, vacuum tube amplifier, or other equipment capable of intensifying the electrical energy produced by a detector to a degree sufficient to affect the controller.

General and Accessory Equipment

1. *Signal Installation*—All of the equipment and material involved in the signal control of traffic at one intersection.

2. *Signal Support*—The physical means whereby a signal head is supported in a particular location.

3. *Lens*—That part of the optical unit which redirects the light coming directly from the lamp and its reflector.

4. *Optical Unit*—An assembly of redirecting cover glass or lens, reflector, lamp and lamp socket with the necessary supporting parts to be used for providing a single signal indication.

5. *Cabinet*—A dustproof and weatherproof enclosure for housing the controller and associated equipment.

6. *Emergency Feature*—A relay or other device installed in a controller which, when energized from a remote point, discontinues the normal signal operation and displays special signal indications for unusual conditions.

7. *Power-Failure Indicator*—A pilot lamp mounted on or in the controller cabinet which, when illuminated, indicates that power has failed and that the controller requires manual recoordination.

8. *Recall Switch*—A manual switch in a traffic-actuated controller which may cause the automatic return of the right-of-way to a street regardless of the absence of actuation on that street.

Definitions Relating to Islands

1. *Approach End (or Nose)*—An end of an island or area between roadways which faces approaching traffic passing to one or both sides.

2. *Buffer*—A structure at the approach end of a safety zone designed to deflect or stop any vehicle which collides with it.

3. *Island*—An area within a roadway from which vehicular traffic is intended to be excluded, together with any area at the approach thereto occupied by protective deflecting or warning devices.

4. *Island, Channelizing*—A traffic island located in a roadway area to confine specific movements of traffic to definite channels.

5. *Island, Divisional*—A traffic island, usually elongated and narrow, following the course of the roadway to separate traffic moving in the same or opposite directions.

6. *Island, Loading*—A pedestrian island especially provided for the protection of transit vehicle users.

7. *Island, Pedestrian Refuge*—An island designed for the use and protection of pedestrians. A pedestrian island includes the safety zone together with the area at the approach end occupied or outlined by protective deflecting or warning devices. This includes loading islands.

8. *Island, Traffic*—An island designed to separate or direct streams of vehicle traffic. Included are both divisional and channelizing islands.

9. *Median Lane*—A speed-change and storage lane within the median to accommodate left-turning vehicles.

10. *Raised Bars*—A series of bars extending above the normal pavement surface to make any wheel encroachment obvious to a vehicle operator without loss of control of the vehicle.

11. *Safety Zone*—The area or space officially set apart within a roadway for the exclusive use of pedestrians, and which is protected or is so marked or indicated by adequate signs as to be plainly visible at all times while set apart as a safety zone.

12. *Traffic Button*—A rounded object extending above the normal pavement surface for the purpose of channelizing traffic movement.

Definitions Relating to Construction and Maintenance Traffic Controls

1. *Barricade*—A portable or fixed barrier having object markings, used to close all or a portion of the right-of-way to vehicular traffic.

    a. *Wing Barricade*—A barricade placed on the road shoulder as a warning device, implying a constriction or closing of the roadway ahead.

2. *Flasher*—A portable power-operated lens-directed enclosed light, illuminated by rapid intermittent flashes of short duration, temporarily installed for advance warning or for the marking of severe or unexpected hazards in or near the roadway.

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